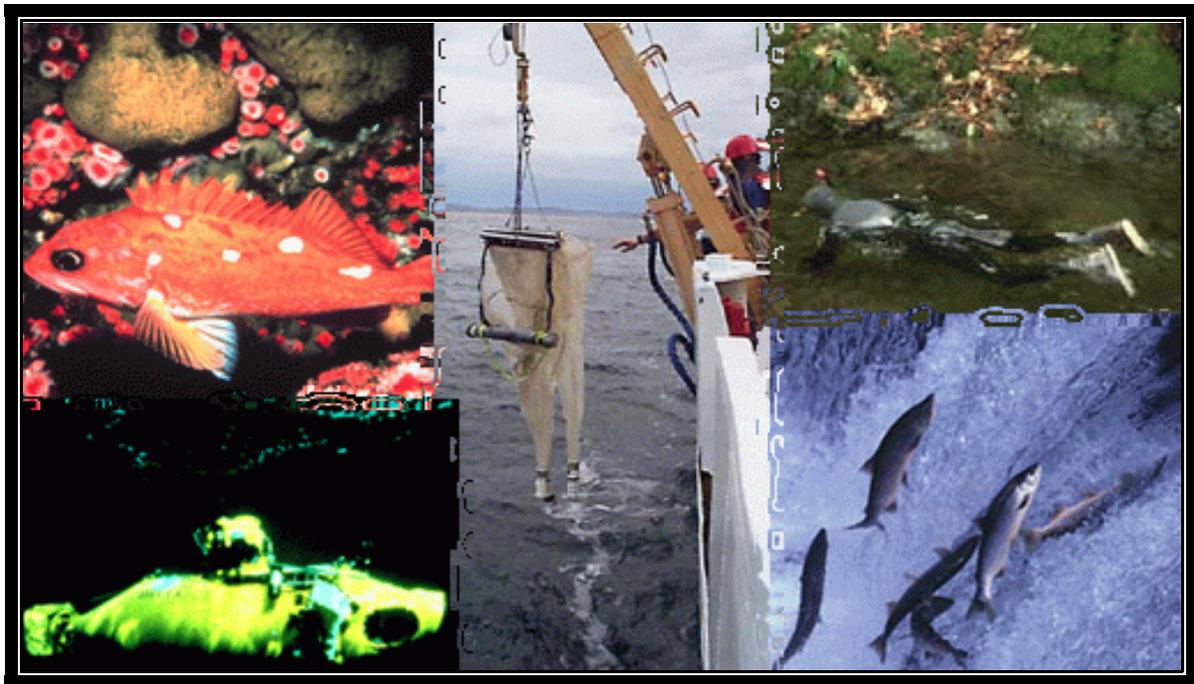


SANTA CRUZ LABORATORY PROGRAM REVIEW 2001

September 5, 2001



**U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center
Santa Cruz Laboratory
110 Shaffer Road
Santa Cruz, CA 95060**

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AGENDA
Wednesday, September 5

I.	Welcome and Introduction	Grimes	0830 - 0900
II.	Research Program Presentations		
	1. Fisheries Branch		
	Groundfish Team	MacCall	0900 - 1000
	Stock Assessment		
	Field Surveys		
	BREAK		1000 - 1030
	Salmon Team	Adams	1030 - 1200
	Modeling and Field Studies		
	Harvest Management		
	Economics		
	LUNCH		1200 - 1330
	2. Ecology Branch	MacFarlane	1330 - 1530
	Salmon Ecology		
	Genetics		
	Habitat Ecology		
	BREAK		1530 - 1600
III.	Discussions with Science Director		1600 - 1700
	ADJOURN		1700

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Laboratory Director

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Computer Specialist

Lisa DeQuattro
Computer Specialist

Lisa Wooninck
Fisheries Biologist

LCDR Julia Neander
Assistant to the Director

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Steve Miller, AO

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Fisheries Branch
Pete Adams, Chief

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Groundfish
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Salmon Population
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Cindy Thomson
Fisheries
Economics Team

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Sarah Lyons
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Kaya Pederson

Organization, Programs, Partnerships and Facilities

Organization

The National Marine Fisheries Service (NMFS) is a division of the National Oceanic and Atmospheric Administration (NOAA), which resides in the United States Department of Commerce. NMFS can be referred to as NOAA Fisheries. The field operations in NMFS are divided into 5 geographic regions. The southwestern U.S. and Pacific Islands fall within the jurisdiction of the Southwest Region (SWR), headquartered in Long Beach, California and the Southwest Fishery Science Center (SWFSC) located in La Jolla, California.

The Santa Cruz Laboratory is one of four laboratories comprising the SWFSC. In addition to La Jolla and Santa Cruz, the other laboratories are located in Honolulu, Hawaii and Pacific Grove, California. The Director of the Santa Cruz Laboratory, Dr. Churchill B. Grimes, reports to Dr. Michael Tillman, Science Director of the SWFSC, through his deputy Dr. Richard A. Neal.

Core Research Program and Partnerships

The research program of the Santa Cruz Laboratory is focused in two primary areas: 1) biological and economics research supporting the restoration and recovery of threatened and endangered salmon in California, e.g., distribution and abundance, population dynamics, genetics, ocean and estuarine ecology of juveniles, and ocean habitat utilization by adults; 2) the biological basis of rational management of west coast groundfish resources, e.g., population dynamics and stock assessment, recruitment processes, habitat ecology and marine protected areas.

Cooperative relationships with other organizations assist the laboratory in accomplishing the research mission. The laboratory houses the National Science Center for Marine Protected Areas (MPA), newly created by a Presidential Executive Order, the center is a partnership between two NOAA agencies, NMFS and the National Ocean Service (NOS). The MPA Center supports research relevant to siting, evaluation and implementation of MPA's for conservation and management of a variety of cultural and biological resources. The principal academic partner of the laboratory is the University of California at Santa Cruz (UCSC) with whom laboratory scientists conduct many collaborative research projects, and participate in graduate academic programs through courtesy faculty appointments. The Center for Stock Assessment Research (CSTAR) is a new feature of the partnership with UCSC. Other research partners include United States Geological Survey, the University of California at Santa Barbara, Moss Landing Marine Laboratories, Humboldt State University, California State University Monterey Bay, Duke University, California Department of Fish and Game and the Monterey Bay Salmon and Trout Project.

Facility

The new NMFS laboratory at Santa Cruz replaced obsolete facilities at Tiburon, California. The new state of the art 53,400 square foot facility includes: office accommodations for approximately 44 administrative and scientific staff; ultramodern biological and chemical

laboratories that support cutting-edge analytical approaches ,e.g., in biochemical genetics and otolith micro structural and micro chemical analysis; latest information technology infrastructure, e.g., copper and fiber-optic cable drops in nearly every work space, LAN of latest PC and workstation platforms and peripherals to support computationally intense modeling analyses, connectivity to University of California system-wide networked assets such as on-line journals; environmentally friendly design; experimental seawater and freshwater aquarium systems with digital control of environmental conditions and extension of seawater to exterior spaces where large volume experiments can be conducted; digital and motion sensor control of the environment in all interior spaces; digital imagery laboratory for analysis of *in situ* video, acoustic and electro-optic imagery for seafloor mapping and GIS georeferencing and layering.

Santa Cruz Laboratory Relocation

Construction Milestones

Summer 2000	Framing, roofing, and infrastructure completed
Fall 2000	Dedication ceremony held, exterior painting & paving completed, office furniture installed
December 2000	Occupancy of Administration and Office wings, interior finish work and landscaping
Summer 2001	Final acceptance of entire building
Pending	Seawater Intake System

Tiburon Closure

March 2001	Substantial move-out completed
August 2001	Environmental cleanup certified
October 2001	SFSU issued License for Use
Pending	Final Excess process through GSA

FISHERIES BRANCH

The Fisheries Branch brings together the management-related tasks within the new organization of the Santa Cruz Laboratory, and because of this is heavily oriented toward quantitative population biology. The Branch also carries out basic research into the underlying biological mechanisms that control the population dynamics of the fishes under consideration, as well as research directed toward critical information needs. The Branch consists of the Salmon Population Analysis Team, the Economics Team, and the Groundfish Analysis Team.

Salmon Population Analysis Team

Introduction

The scientific focus of the Salmon Population Analysis Team is to understand the population dynamics of both endangered and exploited salmonid stocks in California. The Team conducts quantitative studies incorporating population life history characteristics, population estimation, and modeling. Implicit in this scientific focus is management application. The largest commitment is in support of activities mandated by the Endangered Species Act (ESA). The Team has participated in all Listing activities within the Southwest Region, the creation of Technical Recovery Teams for Southwest Recovery Domains, and provided guidance and input on numerous other endangered species issues and activities. The need for information and advice on endangered species issues appears to be infinite. The other major Team responsibility is in salmon harvest management. The Team supports the Pacific Fishery Management Council (PFMC) through participation in the PFMC's Salmon Technical Team and the Klamath Fishery Management Council (KFMC) through participation in the KFMC's Klamath River Technical Advisory Team.

The Team is a recent addition to the SWFSC and is still developing its capacities. The coastwide declaration of anadromous salmonids as candidate species under the ESA in 1992 created a tremendous demand for salmon information and analysis. By 1995, the need was so pressing that personnel at the (Tiburon) Laboratory were reprogrammed to develop a SWFSC salmon research capacity. The program has grown rapidly, yet still has a total of seven positions to fill. Much of the Team's research is both novel and still in its initial stages, and will require the development of new and original methods.

Objectives

The Salmon Population Analysis Team's goal is to conduct the research needed to support salmonid ESA and Council harvest activities. In addition, the Team conducts basic research that will provide the underlying theoretical structure of these activities in order to improve salmon management in the future. More specific goals are:

- to collect or to coordinate collection of critical population distribution and abundance data needed for assessments of salmonid populations;

- to establish appropriate and statistically robust survey methods and population estimators for use in salmon research and management;
- to investigate critical salmon life history characteristics (abundance, distribution, mortality, straying, etc.) needed for a comprehensive management approach to Pacific salmon and steelhead;
- to develop methods for modeling population viability and metapopulation dynamics for use in ESA assessments;
- to provide salmon harvest management guidance, through modeling and focused biological studies, to the Councils, SWR, and other appropriate groups; and
- to provide scientific expertise to the SWR and other appropriate groups.

ESA Assessment and Support

Listing Species - ESA listing activities in the Southwest Region have been completed. Most anadromous salmonids are now listed, and all of the geographical area of anadromy within the Southwest is designated as critical habitat. Coho salmon are listed everywhere they occur in California (Southern Oregon/Northern California Coast Coho ESU - Threatened, and Central California Coho ESU - Threatened). Steelhead are also listed everywhere they occur in California (Northern California Steelhead ESU - Threatened, Central California Coast Steelhead ESU - Threatened, South-Central California Coast Steelhead ESU - Threatened, and Southern California Steelhead ESU - Endangered, Central Valley California Steelhead ESU - Threatened) except in the Klamath Mountains Province where they remain a Candidate species. Listed chinook ESUs include the California Coastal Chinook ESU (Threatened), the Central Valley Spring-run Chinook ESU (Threatened), and the Sacramento River Winter-run Chinook ESU (Endangered). The Central Valley Fall and Late Fall-run Chinook ESU retains Candidate species status.

Technical Recovery Teams - ESA Recovery Planning is designed to occur in two phases, and will be conducted within geographically defined Recovery Domains, of which there are four in California. Phase I is the development of Technical Recovery Goals and is the responsibility of the SWFSC. These goals will be developed by Technical Recovery Teams (TRTs) that will be chaired by Salmon Population Analysis Team personnel. The TRTs will be responsible for developing criteria that, when met, will allow listed salmonid ESUs to be removed from the Endangered Species List. The Teams will include academics, agency personnel, and local experts on salmon biology. The TRTs are selected through a process that begins with a call for nominations, followed by a review of candidates by an outside panel, and selection by the SWFSC. To date, teams have been formed for two Recovery Domains: the Southern Oregon/Northern California Recovery Domain (Elk River, OR to Punta Gorda, CA), and the North-Central California Recovery Domain (Punta Gorda CA to Santa Cruz CA). These teams will begin work in October. TRTs for the South-Central California Coast Recovery Domain (Santa Cruz CA to Malibu Creek CA) and the California Central Valley Recovery Domain are in

the process of being formed. TRT activity will be the primary focus of the Team for the next several years.

Other Studies and Activities

- *Estimation of Smolt Abundance* - Outmigrant trapping is used to estimate abundance of salmonid smolts in many small watersheds. Mark-recapture techniques, in which fish are taken from the trap, marked, released above the trap, and recaptured, are employed to measure trap efficiency. The standard methods used for analyzing this type of data often perform poorly when applied to data from small salmonid populations. We developed a new robust method for estimating smolt abundance based on these data that appears to perform well, and which addresses the deficiencies of standard methods. Potential changes in physical trap design are also being evaluated in hopes of reducing trap-related mortality in these experiments.
- *Juvenile Salmonid Abundance Estimation* - Methods for estimation should be practical, efficient, accurate, cost-effective, and non-injurious. The Team is working with Humboldt State University researchers to develop two-phase ratio estimation survey designs in which visual snorkel dive counts made in a large number of stream units are calibrated against estimates of abundance made for a subsample of these units. To reduce impacts on endangered fish and to reduce survey costs, we are exploring the potential of relying primarily on repeated dive counts rather than electrofishing-based methods for determining abundance in the calibration samples. Genetic markers are being used to evaluate the accuracy of visual discrimination of juvenile steelhead, cutthroat trout, and their hybrids. Together these methods should improve statistical validity, speed field execution, and minimize sampling-related fish mortality in small stream surveys.
- *Coho Survival in Habitats of Varying Quality* - This is a long-term collaboration with Humboldt State University to examine habitat factors that affect survival of coho salmon during the freshwater phase of their life history. Currently, data have been collected on (1) abundance and distribution of spawners, redds, juveniles, and outmigrating smolts in three streams ranging from pristine to heavily impacted by logging and landslides; (2) the use of overwintering habitat by juvenile coho salmon, and the consequences of different habitats for growth and survival; (3) the existence of a life-history variant in which approximately 20% of the juveniles spend a second winter in freshwater, which was previously undocumented in California; and (4) variation in fry production from redds as a function of habitat quality.
- *California Hatchery Review* - The California Department of Fish and Game and NMFS conducted a joint review of California's anadromous fish hatcheries. The review satisfies an ESA requirement that the effects of hatchery operations on listed species be evaluated and, if necessary, authorized under the ESA. The major conclusions of the review are: (1) fall- and spring-run hatchery chinook salmon should be released "in-river" and not trucked to distant downstream sites; (2) a formal process should be identified for the periodic review and assessment (e.g., every 6-9 years or 2-3 brood

cycles) of hatchery production levels; (3) a constant fractional marking program should be established at all hatcheries; and (4) Hatchery and Genetics Management Plans should be developed for each hatchery. The review is currently in a draft form and is being circulated for public comment.

- *Coho Status Review Update* - A coho salmon status review update was prepared for the Southwest Region which concluded that coho salmon have declined substantially since the last status review. Analysis of presence-absence information indicates that the probability of detecting coho salmon in streams where they were historically present has declined significantly from 1989 to 2000, which suggests a downward trend in abundance and possible local extirpation of some stocks. Population trend data were less available, but indicate a significantly higher probability that abundance in extant coho populations has decreased rather than increased in recent years. Both trend and presence-absence data indicate declines have been more precipitous in the Central California Coast ESU than in the California portion of the Southern Oregon/Northern California ESU.
- *Cutthroat Trout Distribution and Population Structure* - This research project is part of a doctoral research project begun at Oregon State University to examine range-wide geographic variation in genetic and meristic characters of coastal cutthroat trout. This work lays a conceptual framework for understanding how habitat variability might interact at various spatial and temporal scales to shape the distribution and persistence of populations. Coastal cutthroat trout exhibit a greater amount of life-history and genetic diversity within and among small, local populations than do other species of Pacific salmonids, and thus provide an opportunity to examine how small populations persist in dynamic environments.
- *An Ecosystem Approach to Salmonid Conservation* - The manuscript titled “Resisting extinction: an ecosystem approach to salmonid conservation” is being revised for publication in book form. Originally published in 1996, this book reviews fundamental principles of salmonid biology relevant to conservation planning, provides detailed reviews of the influence of human activities on salmonids and their habitat, and recommends a broad strategy for conserving salmonid habitats on nonfederal lands and monitoring conservation activities. This information is widely used by both the NWR and SWR in ESA salmon documents. The book has an anticipated publication date of 2002.
- *Quantitative Risk Assessment of Central Valley Chinook and Steelhead Populations* - NMFS is undertaking quantitative extinction risk assessments of all salmonid populations within ESA-listed ESUs on a regional basis. At the core of the analysis is the random-walk-with-drift (RWWD) model of extinction. We have developed a new robust method for estimating the RWWD model that is applicable to spawning data affected by numerous sources of error. The method has been applied to chinook salmon and steelhead trout spawning escapement data from California’s Central Valley. According to the RWWD model, most salmonid populations in the Central Valley are at moderate (5-50%) to extremely high (>50%) risk of extinction within 100 years.

However, Sacramento River fall-run chinook were concluded to be at low (<1%) risk of extinction, but this is likely an overly optimistic assessment as the analysis does not account for the influence of hatchery strays on the population's dynamics. To address this and other shortcomings of RWD analysis, the Team is working to reformulate the model and the approach used to estimate its underlying parameters.

Harvest Issues and Council Support

The Team contributes directly to ocean salmon fishery management by: (1) conducting research on the models and estimation methods used by the Pacific Fishery Management Council (PFMC) and other entities to manage California's ocean salmon harvest; (2) providing scientific guidance to SWR Sustainable Fisheries on the development of Biological Opinions and NMFS harvest jeopardy standards for ESA-listed stocks; and (3) serving on the PFMC's Salmon Technical Team and the Klamath Fishery Management Council's (KFMC) Klamath River Technical Advisory Team. Recent contributions in these areas include:

- *Harvest Rate Model for Klamath River fall chinook salmon* - The KFMC uses this model to guide harvest management policy development, and to examine the expected outcome of particular management actions in a given year. The Team recently revised this model to provide an explicit analytical solution of optimal harvest levels subject to user-group harvest allocation constraints and spawner escapement goals. We also coupled this model with a stock-recruitment model to evaluate the long-term implications of prospective KFMC management policies. In other work, we used the model to assess the probability of reaching the spawner escapement goal in any one year given the noisy data inputs and the escapement level targeted by management entities.
- *Klamath River Ocean Harvest Model* - This is a key model used by the PFMC in developing annual salmon harvest management regulations off the coasts of California and Oregon. The Team continues to lead an effort by NMFS, CDFG, and ODFW to overhaul this model and its input databases. Completed tasks include: (1) review and correction of catch, fishing effort, and escapement databases; (2) reformulation of the cohort reconstruction model to account properly for release mortality, dropoff mortality, natural mortality, and straying; (3) development of a size-at-age model; and (4) estimation of historical harvest and maturation rates. Remaining tasks include: (1) relating harvest rates to fishing effort; (2) forecasting effort as a response to management regulations; and (3) prediction of total chinook landings (all stocks).
- *California Coastal chinook ocean harvest jeopardy standard* - The Team counseled SWR Sustainable Fisheries on the development of a NMFS jeopardy standard on this ESA-Threatened ESU. The scant data available indicate that the ocean distribution of California Coastal chinook is similar to that of Klamath River fall chinook. Therefore, the projected age-4 ocean exploitation rate on Klamath River fall chinook was taken as a proxy of the same for California Coastal chinook, which under the new jeopardy standard must not exceed 17%.

- *Hook-and-release mortality in California's ocean recreational fishery* - Hook-and-release mortality is an increasingly important source of mortality in ocean salmon fisheries due to the increased use of selective-take fisheries by the PFMC to reduce impacts on listed stocks, and because Amendment 14 of the Pacific Coast Salmon Plan now requires a complete accounting of "by-catch." Based on a recent review of data on coastwide ocean recreational hook-and-release mortality rates by the PFMC Salmon Technical Team, the PFMC adopted a rate of 14% to be used in modeling PFMC fisheries except in the case of the California drift mooch fishery, where it was anticipated the rate was probably much higher due to the prevalence of gut-hooking in this fishery. The Team subsequently estimated this rate to be 42% ± 8% based on data provided by the California Department of Fish and Game.
- *Direct Council participation* - The Team participates during all phases of the PFMC and KFMC annual salmon management process as members of the PFMC Salmon Technical Team and the KFMC Klamath River Technical Advisory Team. These duties include: (1) providing modeling and statistical expertise and recommendations on matters before the Councils; (2) modeling the effects of PFMC actions and regulations to evaluate compliance with the salmon FMP and ESU jeopardy standards; (3) producing reports for the PFMC documenting the data, models, forecasts, and regulations adopted each year, and the statistical data resulting from previous years' fisheries.

Accomplishments

- Completion of Southwest ESA listing activities.
- Establishment of Technical Recovery Teams for the Southern Oregon/Northern California Coast Recovery Domain and the North-Central California Coast Recovery Domain.
- Completion of "Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coast evolutionarily significant units."
- Completion of "Draft final report on anadromous salmonid fish hatcheries in California."
- Provided scientific guidance to SWR Sustainable Fisheries on development of NMFS Biological Opinion "Effects of the Pacific Coast salmon plan on California Central Valley spring chinook, California Coastal chinook salmon."
- Assessed chinook stock status and fishery landing data, stock abundance forecasts, and analyzed PFMC proposed management regulations against PFMC salmon FMP and NMFS jeopardy standards. Preparation of Council documents.
- Developed ocean stock abundance estimates for Klamath River fall chinook spawning abundance and river spawner age-composition for KFMC.
- Lead collaborative NMFS, CDFG and ODFW effort on reformulation of the Klamath Ocean Harvest Model and underlying databases.
- Estimated pinniped predation levels on adult salmon in Klamath River estuary based on data collected by Yurok Tribal Fisheries Program.

- Provided Yurok Tribal Fisheries with sampling and estimation protocols for Tribe's commercial fishery harvest, and spawning and escapement estimators for coho salmon and steelhead.
- Participated in review of salmon harvest impacts on Sacramento winter-run chinook.
- Provided guidance and review for hook-and-release mortality rate assessment in ocean salmon recreational fisheries.
- Authored a species account for the upcoming revision of California's Living Marine Resources and Their Utilization (Coastal Cutthroat Trout *Oncorhynchus clarki clarki*).
- Served on Joint Scientific and Technical Team for California Department of Fish and Game's Steelhead Research and Monitoring Program.

Economics Team

The Economics Team provides data, methods, and analyses needed to: (1) address economic issues associated with 4(d) rules and recovery plans for ESA-listed salmonid stocks, (2) devise practical approaches to addressing fishery management issues such as harvest overcapacity, and (3) develop models that predict the economic effects of regulatory restrictions on the salmon and groundfish fisheries. The primary goals of these economic studies are fundamentally the same as the Salmon Population Analysis Team biological studies, but the focus is on the human impact of ESA and harvest actions rather than the biological impacts. The Team serves on the PFMC's Scientific and Statistical Committee and has chaired the Committee for the last two years. The Team also serves on technical advisory committees, disseminates research results, and reviews manuscripts and research proposals as requested.

Economic Analysis in Support of Recovery Planning for Listed Salmonids

The Endangered Species Act mandates that restoration costs be considered in the course of developing recovery plans. The Economics Team is preparing to meet this need through the following activities:

- *Habitat Restoration Cost Workshop* - The Team organized and chaired a workshop to evaluate the feasibility of developing and applying standardized methods to estimate costs of restoring salmonid habitat. Workshop presentations were made by 22 engineers, geologists, hydrologists, biologists and economists representing federal and state agencies, private consulting firms, and private non-profit organizations. The workshop was funded by the NWR with F/PR monies, and meeting logistics were handled by the Pacific States Marine Fisheries Commission (PSMFC). Workshop proceedings are in preparation.
- *California Salmon Habitat Restoration Project Database* - The Team initiated development of a database containing the following detailed information for existing restoration projects in California: project description, location, project dates, monitoring, participants, land ownership, affected species, and detailed budget information. The database will serve as a repository of information on California restoration projects, will facilitate geographic analysis of projects, and will provide the data needed to develop models for habitat restoration costs. The database is managed under a cooperative agreement with PSMFC.
- *Western States Small Business Database* - To support the evaluation of the effects of ESA 4(d) rules on small businesses, as required by the Regulatory Flexibility Act, the Team has created a database that describes the numbers and distribution of small businesses in California, Oregon, Washington and Idaho that engage in industries potentially affected by the ESA.

Economic Analysis in Support of Fishery Management

- *Economic modeling of entry/exit decisions in fisheries* - The Economics Team has developed a “real options” modeling framework that provides insights into the effect of fishers’ expectations of catch on their decisions to enter or to exit a fishery, the effects of particular types of limited-entry and buyback schemes on effort and latent capacity, and the management implications of diverting effort from salmon to other fisheries (e.g., groundfish). Early results are promising, with the model accurately predicting entry/exit decisions by salmon trollers 73% of the time (compared to 35% of the time for the model customarily used to predict entry/exit decisions). The model is potentially applicable to a variety of management issues, such as: (1) predicting industry response to regulatory changes, which typically is the most difficult aspect of regulatory analysis; (2) evaluating alternative schemes for reducing capacity in the open access groundfish fishery, which is a high priority issue in California; and (3) and enhancing the predictive ability of salmon harvest models.
- *Coastwide Surveys of Marine Recreational Anglers* - Recreational fishery data are needed to evaluate economic effects associated with recreational harvest restrictions, commercial-recreational allocation issues, marine protected areas, and salmon hatchery practices. To address these needs, the Economics Team has initiated planning and design of coastwide surveys of marine anglers, the most recent of which was conducted in 2000.

Accomplishments

- Organization of Habitat Restoration Cost Workshop.
- Presentation of paper on “The Allocation Problem in Habitat Restoration” at Habitat Restoration Cost Workshop (to be published in workshop proceedings).
- Entry of 1300+ California Department of Fish and Game (CDFG) projects into California Habitat Restoration Project Database.
- Creation of ESA small business database.
- Served as chair of Pacific Fishery Management Council’s Scientific and Statistical Committee (SSC) and SWFSC representative on RecFIN Committee.
- SSC Economic Subcommittee report entitled “Report on Overcapitalization in the West Coast Groundfish Fishery: Background, Issues and Solutions”.
- Developed sampling protocol and questionnaire design for economic survey of marine anglers completed in 2000.
- Developed cost-earnings survey of charter boat operators implemented in 2001.

- Presented paper on “Modeling California Salmon Fleet Dynamics” at 2001 meeting of the North American Association of Fisheries Economists (to be published in meeting proceedings).
- Presented “Real Options Analysis of Entry and Exit in Fisheries” at NMFS national economist meeting.
- Completed economic profile of California commercial and sport fisheries (to be published as part of larger report on California’s living marine resources, as required by Marine Life Management Act).

Groundfish Analysis Team

Introduction

The Santa Cruz Laboratory has supported essential needs of the National Marine Fisheries Service (NMFS) and the Pacific Fishery Management Council (PFMC) for information on groundfish for over 20 years. Laboratory scientists have been members of the PFMC's Groundfish Management Team (GMT) every year since its inception in 1977, and have made many significant contributions in the form of stock assessments, development of new methods, evaluation of alternative management procedures, and collection and processing of important data on fisheries and resources. In view of the deteriorated condition of groundfish stocks along the U.S. west coast, the need for technical information on groundfish is critical, especially for the California component of the fishery.

Objectives

The goal of the Santa Cruz Laboratory's groundfish research programs is to support the information needs of the PFMC regarding Pacific coast groundfish stocks. Specific objectives are as follows:

- **Resource Information:** Collect and develop information that is useful in assessing and managing groundfish stocks, including both fishery-dependent and fishery-independent information (e.g., resource surveys), ecological and oceanographic studies.
- **Resource Assessment and Policy Analysis:** Conduct stock assessments that provide an understanding of the status and dynamics of groundfish stocks as a basis for harvest management decisions, and evaluate alternative harvest policies that have the potential to improve management performance.
- **Dissemination:** Disseminate information, research findings and associated advice to the fishery management community, including appropriate fishery management agencies, to the scientific community, and to the interested public.
- **Service:** Provide professional services (many of which fall in the above categories) at all levels, from Santa Cruz Laboratory support to participation in inter-agency, national and international working groups.

Accomplishments

Direct Council Support

Groundfish Stock Assessments and Rebuilding Plans

<u>Stock Assessments:</u>		<u>Rebuilding Plans:</u>	
Bocaccio	1999	Bocaccio	2000
Lingcod (south)	1999	Pacific Ocean Perch	2000
Widow rockfish	2000	Widow rockfish	2001
Black rockfish	2001		
Bocaccio	planned 2002		
Other Rockfish	method in development		

The 2001 black rockfish assessment was withdrawn after we were informed that the recreational catch-per-unit-effort (CPUE) index provided by the Oregon Department of Wildlife and Fisheries was in error. Values for the most recent two years were about half their proper value, causing the assessment to underestimate stock abundance. It was too late in the model development and review process to re-do the assessment. When the corrected CPUE was used in the model (but without full “tuning”), the assessment indicated no apparent need to modify current management. Assessment of black rockfish off Washington has been scheduled for 2002, and we will urge that assessment effort to be expanded to a coastwide coverage (we will not participate).

In 2002, bocaccio will be assessed for the first time since the rebuilding plan was initiated in 2000. Critical issues include determination of the size of the apparently strong 1999 year-class, and technical adjustments to the rebuilding plan according to information provided by a new stock assessment.

Groundfish Harvest Rates – Revision of the PFMC’s policy on groundfish harvest rates has been an active area of team involvement. Following workshops in February and March 1999, Steve Ralston organized a comprehensive review of groundfish harvest rates that was held in Seattle, March 2000. That review resulted in the PFMC adopting an unusually conservative F50% harvest rate policy for most west coast groundfish stocks. Ralston arranged for the review papers to be published as a “module” in the North American Journal of Fisheries Management (probably November, 2001); Ralston served as editor of the volume. Two of the papers in this module are authored by the Groundfish Analysis Team.

Other Direct Council Support – Alec MacCall continues to serve as the SWFSC member of the PFMC's GMT, and will probably serve a fourth year in 2002. It is our policy that GMT

membership should not generally last more than two years at a time, but we do not yet have a replacement for Erik Williams, who left the Team in late 2000. Steve Ralston has been serving on the PFMC's Scientific and Statistical Committee since 1999, and recently assumed the chairmanship of its Groundfish Subcommittee.

Southwest Region Support – Bocaccio has been petitioned for listing as a “threatened species” under the Endangered Species Act. The Groundfish Analysis Team historically has provided the PFMC with bocaccio stock assessments and rebuilding analyses, and these will form the basis of a formal Biological Opinion which must be completed by early 2002. Due to statutory deadlines, that Biological Opinion will not be able to benefit from the planned assessment of bocaccio in 2002.

Indirect Support for Groundfish Management

Database Management – Don Pearson has worked closely with the California Department of Fish and Game (CDFG) to coordinate port sampling efforts and to design the statistical “expansions” of estimated species landings in the state. He has also made the massive historical trawl logbook information for California and Oregon available for research and stock assessment. Pearson recently completed final development of CALCOM, an Internet-accessible system containing California landings of all species since 1978. The system provides port sampling biologists with Internet access to the database, so that monitoring data is entered directly in real time. CALCOM is the source of the data feeds provided to PacFIN by the State of California.

Archived Otoliths – The collection of groundfish otoliths has been further augmented by samples “rescued” from CDFG that were going to be discarded during relocation of the Menlo Park office. The full collection has been inventoried, and is now fully accessible for use. It contains samples from over 270,000 fish, covering 70 species, and extends back to the early 1970's for some species. Otoliths have been sent to numerous west coast scientists for reading and use in stock assessments. In exchange for the otoliths, we request that the recipients provide us with the age readings for entry into the CALCOM database, but continue to experience problems with compliance.

Surveys and Ecological Research

The Groundfish Analysis Branch has considerable experience in performing fishery-independent sea-surveys. Data collected from these cruises have generally been designed to be useful in the management of west coast groundfish.

Rockfish Recruitment Survey – Rockfish of the genus *Sebastes* exhibit extreme variability in reproductive success, and the productivity of rockfish fisheries depends almost exclusively on the occurrence and influx of strong year-classes. Management of these fisheries therefore

benefits from accurate information on impending recruitment. To meet that need, the Groundfish Analysis Team has used the NOAA vessel *David Starr Jordan* to conduct an annual survey of the distribution and abundance of pelagic juvenile rockfishes since 1983. The goal of the survey is to provide an information base for forecasting future recruitment to rockfish and other groundfish stocks. Because rockfishes recruit at ages 2-6 years old, these surveys provide a fairly long-term forecast of significant fluctuations in recruitment. Many west coast groundfish stock assessments (black rockfish, bocaccio, chilipepper, widow rockfish and Pacific whiting) use our pelagic juvenile index to estimate recruitment strength of existing year classes that are not yet old enough to appear in fishery catches, greatly improving the accuracy of forecasts.

The survey has produced a number of other useful results. We have hosted ornithologists from the Point Reyes Bird Observatory, U. S. Fish & Wildlife Service, and other academic institutions.

Data gathered by these biologists have been widely used in understanding the distribution and foraging behaviors of seabirds. The physical data collected during the surveys (e.g., CTD, thermosalinometer, fluorometer, transmissometer, and ADCP) also have been widely distributed through the publication of annual Technical Memoranda and by fulfilling specific data requests. We have worked closely with the fisheries acoustics program in La Jolla (including participating in Antarctic Surveys) to gain expertise in use of acoustic instrumentation. We now have an in-house ability to process ADCP data, and Dale Roberts has been developing back-scatter indexes of fish and euphausiid abundance.

Future Directions

Bayesian Stock Assessment Methodology – Development of a new Bayesian assessment methodology for relatively data-poor stocks will continue. This is a computationally intensive approach utilizing historical patterns of fishing effort and recruitment strength from data-rich assessments to infer those patterns in data-poor stocks. Performance of a range of possible models must be examined for the trade-off between model detail and parsimony. This will be done by cross-validation, in which the methods are applied to the existing data-rich cases for comparison to the results of full assessments.

Rockfish Larval Production Survey – There is a tremendous need for better information concerning the abundance of west coast groundfish. The Groundfish Analysis Team has worked towards developing a larval production approach to estimating the spawning biomass of rockfishes. Keith Sakuma described the larval stages of chilipepper rockfish, making an ichthyoplankton survey for this species feasible. In January, 2000, we conducted a pilot survey for larval chilipepper rockfish of central California aboard the NOAA ship *McArthur*. Processing of the samples was delayed due to budget limitations in FY2000, but the recent groundfish budget enhancement has allowed us to proceed.

Central California Groundfish Ecology Survey (in development) – Historically, the density of west coast groundfish surveys has been very thin, with stations/strata typically occupied once every three years. In an effort to obtain a more comprehensive understanding of the central California groundfish community and groundfish ecology, the Team will undertake an intensive local groundfish survey beginning in late 2001. The survey will utilize chartered commercial trawl and longline vessels using standardized gear, and operating over a range of depths in an area off Davenport, near the Santa Cruz Laboratory. During the first year, an inshore-offshore suite of stations will be occupied monthly in order to obtain detailed information on annual cycles including species location and co-occurrence, maturation, and otolith edge formation. In subsequent years, the frequency of surveys will be reduced to a smaller number of months that are adequate to sample the important patterns of variability. It is expected that this program will evolve as experience is gained. We also expect this program to provide benefits to the Santa Cruz Laboratory through improved credibility as perceived by the local fishing community – a common complaint is that the fishery scientists do not spend enough time “on the water.”

ECOLOGY BRANCH

The Ecology Branch originated from the Physiological Ecology Branch and part of the Coastal Communities Branch at the Tiburon Laboratory. It is organized into two teams of scientists: Habitat Ecology and Salmon Ecology. Both teams combine basic and applied research to increase understanding of the relationship between fishes and their environment and to provide this information to fishery management. The Habitat Ecology Team identifies and describes essential fish habitat for groundfish species; in particular, those that are managed and overfished. The Salmon Ecology Team focuses on studies that address biological development and genetic relationships of salmonids at the southern margin of their distribution and the influences of estuarine and marine conditions to interannual variability of stock status.

Salmon Ecology Team

Introduction

Salmonid stocks (chinook salmon, *Oncorhynchus tshawytscha*, coho salmon, *Oncorhynchus kisutch*, and steelhead, *Oncorhynchus mykiss*) from California's Central Valley and coastal streams continue to decline. All four of California's Central Valley chinook runs are either listed or candidates for listing by the Endangered Species Act. Coastal chinook, coho, and steelhead evolutionarily significant units are similarly imperiled. Although freshwater habitat loss and degradation contribute to population declines, it is becoming apparent that estuarine and ocean conditions play a major role in the interannual variability in salmon biology, especially during the first months after exiting freshwater. Climatic and oceanographic physical forcing, on temporal-spatial scales ranging from interdecadal-ocean to interannual-mesoscale to seasnail localized phenomena, affect marine productivity and environmental conditions that influence salmon growth, development, and survival.

Effective management of salmonid stocks and their ecosystems requires greater knowledge of the abundance, distribution, growth, health, and ecology of juvenile salmonids during estuarine and marine residences. The need for basic biological data and the influences of environmental factors on survival and health have been identified as high priority research needs by the Pacific Fishery Management Council (Research and Data Needs 1998-2000, PFMC, September 1998) as well as the scientific community (Estuarine and Ocean Survival of Northeastern Pacific Salmon, Proceedings of the Workshop, April 1997; NMFS Estuarine and Ocean Salmon Strategic Research Plan, April 1998). Implicit in these needs is the ability to distinguish separate populations, including those of natural and hatchery origins, and to differentiate the influences and consequences of marine and freshwater processes on individual stocks. The research projects conducted by the Salmon Ecology Team provide information that will help focus conservation and management efforts on the most cost-effective options for this socio-economically valuable resource.

Objectives

- I. Ocean Ecology: Determine abundance, distribution, growth, energy status, trophodynamics, and the influences of oceanographic features and processes.
- II. Estuarine Ecology: Determine juvenile salmonid residence time, seasonal abundance, growth, energy status, trophodynamics, and the effects of environmental conditions.
- III. Molecular Genetics: (1) Provide comprehensive assessment of genetic population structure for California salmonids, (2) Establish a repository of salmonid genetic material for use by NMFS and other researchers, (3) Develop new methods for the analysis of molecular genetic data and apply them to protected species, and (4) Develop new genetic tools to estimate trophic interactions between salmonids and marine mammals.
- IV. Hatchery - Wild Interactions: Determine the types, extent, and consequences of interactions between naturally-spawned and hatchery-produced steelhead.
- V. Coho Captive Broodstock: Establish two year-classes of captive coho salmon from Scott and/or Waddell Creeks to aide in the persistence and recovery of the population at the southern margin of their distribution.

Methods and Approach

Ocean Ecology

- Survey and collect salmonids along central California coast by surface trawl soon after ocean entry (June-July) and after several months of residence (September - October). Survey by a series of transects from Pt. Reyes to Cypress Pt. between 15 and 50 fathoms depth and in association with oceanographic features (fronts, upwelling centers, jets, eddies).
- Tag representative salmon with archival tags to record movement history (data from recovered tags).
- Determine growth history by otolith analysis.
- Assess sex, length, weight, maturation state, physiologic condition (tissue morphometrics, Goede's and Adam's health assessment evaluations), energetic and nutritional status (lipid class and protein analyses).
- Analyze species and size-stratified stomach contents (quantity, prey species composition and dominance).
- Establish stock/run identity of individuals by genetics, microchemical otolith analysis, tags/fin clips.

- Estimate primary productivity (calibrated vertical and horizontal fluorometry, CCS satellite imagery) and zooplankton and neuston abundance and speciation.
- Assess forage fish and fish community coincident with juvenile salmonids (identify and enumerate species captured during salmonid collections).
- Obtain environmental data (CTD data - depth profiles of temperature, salinity, PAR; current profiles) concurrent with salmon surveys.
- Incorporate environmental data (e.g., current profiles, freshwater outflow, temperature, salinity, upwelling indices, sea level data, AVHRR and CZCS image data, barometric pressure, rainfall, wind) from other governmental and academic sources.
- Integrate salmonid data with biotic and abiotic oceanographic data to determine variables affecting salmonid biology and other interrelationships.

Estuarine Ecology

- Surveys and sampling are conducted in San Francisco Estuary, and smaller estuaries in Marin to Monterey County. In San Francisco Estuary, juvenile chinook salmon are collected by surface trawl at the estuary entrance and exit in May and June. Surveys in smaller estuaries are presently done by snorkel throughout the year, at weekly to monthly intervals depending upon season and location. When project is fully staffed, seining will be added to snorkel surveys to collect specimens for laboratory analyses.
- Residence time, abundance, growth, and survival will be determined by seasonal surveys using snorkeling and seines. Mark and recapture techniques will be used to determine individual residence time and growth. Fish will be PIT tagged to evaluate return rate, straying, survival, etc. Length and weight will be recorded on lightly anesthetized fish.
- Smoltification will be assessed by non-lethal clips of gill filaments (Na⁺, K⁺-ATPase) and analysis of photographs to record silvering (guanine concentration) and morphometry.
- Representative juveniles will be subjected to stomach content analysis using stomach evacuation techniques. The small fish, plankton, and neuston communities will be assessed (species composition and abundance) to estimate forage community dynamics.
- On selected individuals, small fin clips (~ 0.25 cm²) will be acquired for genetic determination and scale samples for ageing.
- On a small sample or if mortality occurs, fish will be assessed for age by otolith analysis and energy status will be determined (lipid class analysis, protein determination).
- Environmental data (e.g., rainfall, flow, temperature, salinity, pH, dissolved oxygen, turbidity, sandbar status [small estuaries]) will be recorded and related to salmonid dynamics.

Molecular Genetics

- Assessment of genetic population structure:
In support of the ESA Technical Recovery Team and in collaboration with the Fisheries Branch, we have started a large-scale evaluation of genetic population structure for steelhead populations in the Northern California/Central California Coast ESUs. This study involves the

collection of molecular genetic data from samples of 50 individuals from approximately 40 watersheds in the study area. Samples are being collected by field crews from the Santa Cruz Laboratory and collaborators. Genetic markers for which data are being collected include 12 microsatellite markers and sequences from two immunogenetic regions (MHC loci). These data will be used to estimate genetic distances and construct trees of population relatedness. Rates of migration and change in effective population size will also be estimated. A parallel effort for coho salmon is also underway.

- Salmonid genetic repository:

The Repository is a centralized, non-proprietary resource for genetic analysis of salmonids in California. It catalogs and provides long-term storage for genetic material extracted from tissue samples resulting from collecting activities by permitted agencies and individuals throughout California. Requests for purified DNA are granted to researchers who are competent in genetic analysis. The Repository currently holds tissues from 2603 steelhead, 868 chinook and 941 coho salmon.

- Development and application of new analytical methods:

Because of the difference between census and effective population sizes in vertebrates, reductions in effective population size can be hard to detect. To remedy this problem, a novel molecular genetic method for detecting reductions in effective population size has been developed. This method has been applied to many salmonid data sets collected from the literature to identify populations potentially at risk due to genetic effects.

- Molecular genetics in the study of salmonid/pinniped interactions:

The impacts of pinnipeds on salmonid populations are hard to measure. Observational methods and analysis of scat for salmonid hard parts both suffer from inherent biases and often cannot identify an individual fish to species or ESU. To overcome these limitations, we are developing a novel set of molecular genetic methods for the analysis of trophic interactions. These methods will allow a qualitative (i.e., identification to species or ESU) and quantitative (i.e., enumeration of individuals) assessment of pinniped impacts on protected and fishery important species. A UCSC doctoral student working in the Santa Cruz Laboratory will work to implement these methods in the estimation of the impact of sea lions on salmonid populations in the Monterey Bay region. These data will help to assess and evaluate different proposed management strategies for pinniped/fishery interactions.

Hatchery - Wild Interactions

- Project will be conducted on Scott Creek and Waddell Creek, Santa Cruz County. There is a hatchery on a tributary of Scott Creek that fin clip all their hatchery-produced salmon, allowing discrimination between hatchery and naturally-produced fish. Waddell Creek will serve as a control.

- Juveniles:

Juvenile steelhead will be captured by trapping to aid in the assessment of emigration timing and smolt condition. Once captured, the following data will be collected: origin (hatchery, natural), size, and condition factor (K). A small piece of fin tissue will be preserved subsequent DNA analyses (local gene flow, inbreeding/ outbreeding depression). To assess smoltification and the ability to enter the ocean, a small piece of gill filament will be excised for Na^+/K^+ ATPase analysis.

- Adults:

Run timing, stream distribution, individual characteristics - Adults will be caught by seine and sex, origin, length, and weight will be recorded. Before release, a multicolored Floy® tag will be inserted just below the dorsal fin to allow monitoring of hatchery and natural-run spatio-temporal distribution and movement. Fin tissue samples will be subjected to DNA analysis.

Spawning behavior - The watershed will be surveyed to identify spawning habitat. These areas will be surveyed for adult usage and a set of permanent observation stations established to monitor spawning behavior. The data to be collected will include spawning densities, hatchery/natural-run breeding associations, the number of redds and information related to potential correlates of reproductive success. Reproductive success data will be collected on individuals and will include measures of aggression, cuckolding rates and the occurrence of spawning behaviors. In addition, substrate composition, redd size, and redd location as well as water quality measurements (e.g., temperature, dissolved oxygen and flow rate) will be taken to describe redd quality.

Coho Captive Broodstock

- Construct captive broodstock seawater holding facility at the NMFS Santa Cruz Laboratory and satellite freshwater facility at Big Creek Hatchery.
- Acquire captive broodstock as juveniles from Big Creek Hatchery. Juveniles will be progeny of adults trapped from Scott and Waddell Creeks and spawned at the hatchery.
- Maintain two separate year-classes that will provide 100 mature adult southern coho salmon each. All fish PIT tagged for identification.
- Using genetic analysis, maintain and increase genetic diversity of broodstock.
- Provide ripe adults to Big Creek Hatchery for spawning. Gametes from captive coho salmon will be used as last alternative; gametes from naturally-spawned fish (when available) have priority.
- If excess adults are available, place in suitable streams under guidance of NMFS Salmon Recovery Team for Central California ESU
- Perform field and laboratory experiments on subset of progeny from captive broodstock to increase knowledge and understanding of physiological and ecological requirements of southern coho salmon to improve effectiveness of recovery actions.
- Evaluate success of program annually. When naturally-produced southern coho salmon stocks in Scott and/or Waddell Creeks are self-sustaining or after three generations of three captive brood years, whichever occurs first, discontinue program.

Accomplishments

Presentations

2001

- Annual Meeting of the American Society of Naturalists, Knoxville, TN (Garza)
- AFS California-Nevada 35th Annual Meeting , Santa Rosa, CA (Garza [Invited])
- AFS California-Nevada 35th Annual Meeting , Santa Rosa, CA (Johnson, Grimes & Royer)
- Monterey Bay Sanctuary Currents Symposium, Monterey, CA (Johnson, Grimes & Royer, poster)
- University of California, Santa Cruz Ocean Sciences Departmental Seminar (Garza)
- University of California, Santa Cruz Ocean Sciences Departmental Seminar (MacFarlane)
- AFS Larval Fish Conference 25th Annual Meeting, Sandy Hook, NJ (Johnson, Grimes & Royer)
- AFS Larval Fish Conference 25th Annual Meeting, Sandy Hook, NJ (Norton, two posters)
- Women in Science Forum, San Diego, CA (Johnson)
- 5th Biennial State of the Estuary Conference, San Francisco, CA (Norton, poster)

2000

- Interagency Ecological Program Annual Meeting, Pacific Grove, CA (Alonzo & MacFarlane)
- AFS California-Nevada 34th Annual Meeting, Ventura, CA (Alonzo & MacFarlane)
- AFS California-Nevada 34th Annual Meeting, Ventura, CA (MacFarlane)
- International Congress on the Biology of Fish, Aberdeen, Scotland (MacFarlane)
- NOS Gulf of the Farallones National Marine Sanctuary Workshop, San Francisco, CA (MacFarlane & Norton)
- AFS Larval Fish Conference 24th Annual Meeting, La Paz, Mexico (Norton, poster)

1999

- Interagency Ecological Program Central Valley Salmon Conference, Bodega Bay, CA (MacFarlane)

Southwest Region Support, Committees

- Southwest Region Equal Employment Advisory Committee—Chair of the Personnel Subcommittee (Norton, 2000 to present)
- Joint NMFS-CDFG Anadromous Fish Hatchery Review Committee (MacFarlane, 1999 to present)
- Salmonid ESA Technical Recovery Team for North-central California Coast (Garza, 2001)

- Salmonid ESA Technical Recovery Team for California Central Valley (MacFarlane, 2001)
- Russian River Coho Salmon Recovery Work Group (Garza, 2001)

Future Directions

Ocean Ecology - We will continue to survey and collect juvenile salmon, plankton, and oceanographic data on the central California coast to gain better understanding of the interannual variability of ecological and physiological processes and the influences of ocean conditions and features (e.g., eddies, jets, upwelling centers, estuarine plumes, etc.). During the first two years, our study area extended from Pt. Reyes southward to Cypress Pt. We now have sufficient data to conclude that coastal waters south of Pt. San Pedro (at Pacifica) are not used to any significant extent by juvenile salmon. Therefore, starting with the October 2001 survey, our study area will extend from Pt. San Pedro northward to Ft. Ross. This area has not been previously, but includes ocean entry points for juvenile salmonids exiting the Russian River and several productive coho and steelhead streams. The potential to gain greater understanding of the influences of biotic and abiotic oceanographic variables may be increased as well. A large, long-term, NSF-funded research project, conducted by scientists from Bodega Marine Laboratory, Scripps Institution of Oceanography, and other academic institutions, assessing the physical and biological oceanography of wind-driven coastal ecosystems has solicited our cooperation and is willing to share data with us. Their study area extends from Pt. Reyes to north of the Russian River.

Estuarine Ecology - Presently, the San Francisco Estuary and five small estuaries are being studied. Salmon, plankton, and hydrologic data are being collected and analyzed from the entrance and exit to the San Francisco Estuary. We will continue monitoring juvenile chinook salmon usage of this large estuary to increase our understanding of interannual variability and its causes. The study of the smaller estuaries will be expanded to include more estuaries and more ecological and physiological analyses. For the past two years, the study of these estuaries has been limited to snorkel surveys of juvenile salmonid abundance and associated water quality and sandbar status data conducted by Tom Laidig. We are presently evaluating applicants for a Research Fishery Biologist (GS-12) position that will be the principal investigator of the study. Once this position is filled, and with the assistance of Tom and other members of the Salmon Ecology Team, the project will expand in scope as described in the Methods and Approach section.

Molecular Genetics - With the addition of three new geneticists (one GS-12, two GS-9) in the coming year, the salmon genetics research program will expand to include the following:

- genetic population structure will be extended to provide a comprehensive assessment of Central Valley chinook stocks
- the use of molecular genetic methods to study trophic interactions will be extended to examine the use of estuaries by juvenile salmonids
- molecular genetic methods will be employed to estimate reproductive success in steelhead populations in Scott and Big Creeks.

- modern gene mapping methods will be employed to identify genes contributing to determination of life history strategy and reproductive success in steelhead populations in Scott and Big Creeks.

Hatchery-Wild Interactions - This project is funded for two years through a cooperative agreement between NMFS and CDFG, the California Coastal Salmon Recovery Program. A post-doctoral researcher will be hired to conduct the study with the assistance of contracted labor and staff from the Salmon Ecology Team.

Coho Captive Broodstock - We are in the process of purchasing equipment and materials to construct the holding tanks, which will be housed in the Santa Cruz Laboratory's aquarium area and at Big Creek Hatchery (CDFG Cooperative Hatchery, Monterey Bay Salmon and Trout Program). It is expected that this year's adult returns to Scott and/or Waddell Creeks will provide gametes for the production of juveniles at the Big Creek Hatchery. When smoltification of the juveniles is in progress, a genetically-selected cohort will be placed in the holding tanks and maintained until they are mature, when they will be used to provide gametes to supplement those from returning adults to Scott Creek. A Research Fishery Biologist will be hired to culture the broodstock and develop research in support of salmon culture and other program needs (e.g., pathology, immunology, nutrition).

Habitat Ecology Team

Introduction

The reauthorized Magnuson-Stevens Fishery Conservation and Management Act has created a mandate for the National Marine Fisheries Service to identify and describe essential fish habitat (EFH) for managed species, and to protect and restore (where appropriate) these habitats. A second mandate of the Act, which has direct relevance to EFH, is to identify and rebuild those managed stocks that are overfished. Several groundfish species on the west coast have been designated as overfished; it is especially important to characterize and protect EFH of these species. However, the necessary EFH information is either non-existent or incomplete for most groundfish species.

The Santa Cruz Laboratory has developed a research program to effectively respond to the EFH mandate. Several funding opportunities for marine groundfish habitat research both within NMFS and from other NOAA offices (Sea Grant, NURP, Ocean Exploration, NOS), USGS, state agencies, and private foundations have been successfully pursued.

Objectives

- I. Characterize Deep Water Benthic Habitats and Associated Groundfish Assemblages
- II. Develop New Technology to Map Seafloor Habitats
- III. Evaluate Subtidal Rockfish Recruitment and Associated Ocean Conditions
- IV. Consider Marine Protected Areas to Help Conserve and Manage Groundfish and Habitats

Methods and Approach

Deep water fish and habitat associations

Classification of habitat attributes on scales pertinent to animal distributions and ecological problems in marine environments is difficult because of the restricted access to this system. Since 1992, we have been developing new tools, technologies, and partnerships to characterize deepwater fishes and habitats. Our application of geophysical techniques to map the seafloor and submersible observations to directly count fishes along randomly or systematically selected transects at predetermined dive locations has made fish-habitat surveys in deep water commonplace nationwide. Our research addresses goals to improve assessments of groundfish populations, evaluate ecological effects of fishing, describe and conserve EFH, and identify areas in need of additional protection. Our approach is especially critical when focusing on benthic habitats of extreme heterogeneity and biological assemblages of high diversity.

In collaboration with researchers from Moss Landing Marine Labs and CA Dept. Fish and Game and with outside funding from NOAA NURP, Sea Grant, and Monterey Bay National Marine Sanctuary, we have applied this approach to de facto marine reserves in the head of submarine canyons, in and adjacent to the Big Creek Ecological Reserve of the Big Sur coast, and elsewhere along the central coast. The Big Creek Ecological Reserve is one of the few no-take marine protected areas along California's coast. While having limited spatial coverage, this area provides an opportunity to collect empirical data on the protection that reserves provide to various species. The overall project objective was to estimate abundance, species-habitat relationships, and species and size composition of deep water benthic fishes in the BCER area, and to compare these variables inside and outside the reserve and between two years of our study (following only 4-5 yrs of protection). An extensive database of fish species, abundance, size, and habitat associations has been produced, including a detailed accurate map of benthic habitats. The only factor that significantly influenced fish density in our analyses was habitat (higher densities in complex habitats as compared to soft low relief areas). Fish densities did not vary significantly between the two years (1997 vs 1998), and did not vary among sites inside and outside the protected area or depth. We recently have received funding from the Packard Foundation to continue this type of research as part of a monitoring program for a newly established large marine protected area off southern CA (see Future Directions Section below).

Together with colleagues from the NWFSC, we are developing a cooperative and complementary program in marine habitat studies for the west coast region. This collaboration blends several scientific disciplines and objectives and uses state-of-the-art visual survey techniques along with real-time tracking and navigation in association with highly accurate high resolution seafloor maps. Co-investigators from NWFSC, SWFSC and NOAA PMEL and WA State University (and several other associated institutes and agencies) are conducting surveys of fish, macroinvertebrates and benthic habitats off the Oregon coast using the Canadian remotely operated vehicle ROPOS and submersible DELTA onboard the NOAA R/V RONALD BROWN. As part of the new NOAA Ocean Exploration Program, we are surveying the geology, biology, and physical oceanography of Astoria Canyon off the Columbia River. With funding from NOAA NURP we have completed a second year of investigations into the links between groundfishes and seafloor habitats on Heceta Bank, one of Oregon's major fishing grounds. From these surveys we will evaluate changes in fish assemblages and habitat after a decade of intense fishing.

Our staff is also contributing to the efforts of NMFS Office of Science and Technology in producing the first edition of Our Living Oceans Habitat 2000. This report will summarize the status and trends of habitats used by those living marine resources under NMFS purview.

New technologies

One challenge is to efficiently relate small-scale observations and assessments of animal-habitat associations to the large geographic scales on which benthic fisheries operate. Laser Line Scan (LLS) is a recently developed underwater optical imaging technology that shows promise for rapid, high-resolution habitat mapping. The LLS provides high resolution (e.g., it can

differentiate cm-size objects), high contrast underwater light field images at two to five times the range of conventional video and photographic systems. The LLS could bridge the gap between in situ observations and imaging with side scan sonar or multibeam acoustic systems.

In March 2001, we convened a 2-day workshop at the Santa Cruz Lab to facilitate discussion among physicists, ocean engineers, geologists and biologists on state-of-the-art techniques to image the seafloor and process the resultant data into products that are useful in describing fishery habitats. Following that meeting, we participated in a short field demonstration of one LLS system. With funding from NOAA NURP and Office of Ocean Exploration, we will field-test LLS in FY02 in several habitats in order to evaluate its application to fisheries research. We plan to compare results from LLS with those already obtained by other mapping and in situ technologies. We also will develop capabilities to more efficiently post-process the immense quantity of digital imagery generated by LLS.

Subtidal recruitment and ocean conditions

With the decrease in population size of many of the rockfish stocks, accurate forecasting of the biomass that will recruit to the fishery is needed to adequately manage the stocks and set catch quotas. Since 1983, personnel from the Santa Cruz Laboratory have conducted nearshore juvenile rockfish recruitment surveys off the coast of northern California. We estimate the number individuals that survive the pelagic phase, and the recruitment strength for three rockfish species each year. From these long time series we can better predict the year classes that potentially will contribute to the fishery in following years. By comparing these time series with similar results from elsewhere along the coast, we will develop a rockfish recruitment index, determine recruitment timing, and evaluate factors (i.e., environmental and biological) that could influence recruitment on local and coast-wide scales.

In April 2001, we convened a 1-day workshop at the Santa Cruz Lab on nearshore juvenile rockfish studies, with participants from across California. From this meeting we began to standardize assessment methods and interpret results among all similar subtidal surveys. Also, since the lab has moved to Santa Cruz, a new sampling site has been established at the southern end of Monterey Bay for comparisons of recruitment and other life history aspects with that information collected to the north.

Marine Protected Areas

Our staff has initiated and led the efforts to evaluate marine protected areas (MPAs) as a supplemental tool for groundfish management on the West Coast. Staff members organized and convened the first workshop on marine harvest refugia to conserve and manage rockfishes and continued these discussions in a special symposium on marine protected areas for California. Staff served as advisers to the Pacific Fisheries Management Council and produced a technical analysis and report to assist the Council in developing marine reserves as part of a long term Council fishery management program. The Council is now pursuing the second phase of its

marine reserve plan, during which options for the design and location of specific marine reserves will be developed. These published proceedings and reports also are being used by West coast states in evaluating marine reserves as a strategy to conserve and manage nearshore marine resources. A staff member is an appointed scientific advisor on the Master Plan Team for California's Marine Life Protection Act, which is assisting in developing recommendations for Marine Protected Area Networks to the state's Fish and Game Commission. Public workshops to explain the Team's approach to MPAs and to receive comments from interested parties are ongoing. Our staff also serves as scientific advisor to representatives of the fishing community on the central coast, organized as the Alliance of Communities for Sustainable Fisheries.

Accomplishments

Deep water fish and habitat associations

Presentations

- 11th Western Groundfish Conference, Sitka, AK (2000)
- AFS California-Nevada 34th Annual Meeting (Invited Speaker: Plenary Session "Essential Marine and Freshwater Habitats"), Ventura, CA (2000)
- AFS CalNeva , Santa Rosa, CA (2001; Best Poster Award)
- Oceanography Society, Miami, FL (2001; Poster)

Committees

- Member, F/PR ESA Candidate Species Panel to allocate funding for research on marine species of concern to NMFS (1997-present)
- SWFSC representative on Nearshore Rockfish Research Core Team, which assisted Oregon Ocean Program and California Ocean Resources administrators in developing a research proposal for West coast rockfish and habitats (submitted to NOAA COP 2001)
- Member of Graduate Advisory Committee for Moss Landing Marine Laboratories Master's Student in Marine Science
- Member Research Activities Panel of Monterey Bay National Marine Sanctuary (1993-present)

Program Development

- Recruitment of NMFS-USGS post-doctoral researcher
- Summer student hire
- Developed NOAA Habitat Characterization Workplan and FY03 Funding Initiative

Subtidal recruitment and ocean conditions

Presentations

- 11th Western Groundfish Conference, Sitka, AK 11th (2000; poster)
- CDFG Neashore Fishes Surveys Workshop (2001)

Committees:

- Participated in CDFG Marine Life Management Act Nearshore FMP meetings
- Member of CDFG Committee to determine statewide protocols for standardized underwater methods to survey nearshore fish populations.

Program Development:

- Summer student hire
- Convened workshop to coordinate coastwide subtidal rockfish recruitment surveys

Marine Protected Areas

Presentations

- F/PR Candidate Species Workshop, Silver Spring, MD (2001)
- Marine Life Protection Act Public Workshops, Seaside, CA and Morro Bay CA (2001)
- Marine Conservation Biology Institute 2nd Annual Meeting, San Francisco, CA (2001)
- Moss Landing Marine Laboratories, Marine Fisheries Seminar Class (2000)
- Pacific Fisheries Management Council, Portland, OR (2000)
- 80th Annual Meeting of Western Society of Naturalists, Symposium “Marine Reserves: Tools for Sustaining Marine Ecosystems and Fishery Populations”. Monterey, CA (1999)
- University of Washington, Fisheries Departmental Seminar, Seattle (1999)

Committees:

- State of California Marine Life Protection Act Plan Team Member (April 2000-present)
- Pacific Fisheries Management Council, Advisory Committee on Marine Reserves (1999-2001)
- Alliance of Communities for Sustainable Fisheries, Scientific Advisor (2001-)
- Participation in the North American MPA Network Workshop

Future Directions

- We will continue to develop and use methodologies to characterize deepwater groundfish habitats, particularly as they apply to monitoring of marine protected areas. With a 2-yr grant awarded recently by the Packard Foundation, we will initiate monitoring protocol for fish,

macroinvertebrates and habitats on offshore banks in and around the Cowcod Conservation Area off southern CA.

- We will also broaden our scope to analyze fish assemblages and associated habitat characteristics in deep water coastwide in developing a chapter for the book "California's Marine Fishes and Habitats" (L. Allen and M. Horn, eds.).
- We will collaborate with a newly hired 2-year Post doctoral researcher, supported by NMFS-USGS to focus on habitat studies at the interface between fisheries and geology.
- We plan to recruit and hire a Research Fishery Biologist to pursue marine habitat research.

APPENDIX A

CURRICULA VITAE OF THE SANTA CRUZ LABORATORY

CURRICULUM VITAE

NAME: PETER B. ADAMS

PRESENT POSITION: Research Fishery Biologist, Fisheries Branch Chief

EDUCATION: Ph.D., Ecology, University of California, Davis, 1988; M.S., Ecology, University of California, Davis, 1973; B.S., Biology, University of Redlands, 1970.

PAST EXPERIENCE:

1976-present	Fishery Biologist (Research) National Marine Fisheries Service Santa Cruz and Tiburon, California
1999-present	Research Associate Institute of Marine Science University of California, Santa Cruz
1995-present	National Research Council Post-doctoral Fellow
1976	Sea Grant Trainee University of California, Davis

RESEARCH INTERESTS: Modeling of populations and communities, stock assessment, dynamics of exploited populations, statistical analysis, particularly sampling, and line transect population estimates of deep slope groundfishes.

HONORS AND AWARDS: Performance Awards, 1992, 1994, 1996, 1998, 1999, 2000; Outstanding Article in Fishery Bulletin, 1980; Jastro Fellowship, University of California, Davis; Magna Cum Laude, University of Redlands.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: ESA Biological Review Teams for coho salmon, chinook salmon, and steelhead.

SELECTED PUBLICATIONS:

Adams, P. B., E. H. Williams, K. R. Silberberg and T. E. Laidig. 1999. Southern Lingcod Stock Assessment in 1999. *In* Status of the Pacific coast groundfish fishing throughout 1999 and recommended biological catches for 2000. Pacific Fishery Management Council, Portland, Oregon. Appendix, 79 p. Pacific Fishery Management Council, Portland OR.

Adams, P. B., M. J. Bowers, H. E. Fish, T. E. Laidig, and K. R. Silberberg. 1999. Historical and Current Presence-Absence of Coho Salmon (*Oncorhynchus kisutch*) in the Central California Coast Evolutionarily Significant Unit. SWFSC Administrative Report SC-99-02. 26 p.

Adams, P. B. and D. F. Howard. 1996. Natural mortality of blue rockfish *Sebastes mystinus* during their first year in nearshore benthic habitats. Fish. Bull., U.S. 94(1):156-162.

Adams, P. B., J. H. Butler, C. H. Baxter, T. E. Laidig, K. Dahlin, and W. W. Wakefield. 1995. Population estimates of Pacific coast groundfishes from video transects and swept-area trawls. Fish. Bull., U.S. 93:446-455.

Adams, P. B. 1980. Life history patterns in marine fishes and their consequences for fisheries management. Fish. Bull., U.S. 78:1-12.

Lenarz, W. H. and P. B. Adams. 1980. Some statistical considerations of the design of trawl surveys for rockfish (Scorpaenidae). Fish. Bull., U.S. 78(3):659-674.

CURRICULUM VITAE

NAME: JAMIE J. ALONZO

PRESENT POSITION: Research Fishery Biologist, Salmon Ecology Team

EDUCATION: Ph.D., Marine-Estuarine & Environmental Sciences, University of Maryland (*in progress*); M.S., Marine-Estuarine & Environmental Sciences, University of Maryland; B.S., Zoology, University of Idaho.

PAST EXPERIENCE: 2001 Scott Creek, Davenport, California
Currently initiating research focused on life-history variability and hatchery / natural-run interactions in a coastal population of steelhead.

1999 California Central Valley & San Francisco Bay Estuary
Project investigating spatio-temporal trends in smoltification of chinook salmon.

1993-1997 Managua, Nicaragua
Examined mating system of the convict cichlid on a densely populated reef in Lake Xiloá.

1992-1997 Calvi (Corsica), France
Investigated major factors influencing breeding ecology and evolutionary dynamics of three Mediterranean wrasse species.

RESEARCH INTERESTS: Reproductive ecology of fishes.

HONORS AND AWARDS: California Coastal Salmon Restoration Project Research Grant, December 2000; NMFS Achievement Award (*Chinook Smoltification* project), February 2000; MEES Travel Grant to Tropical Fish Biology Symposium, 1998; STARESO Research Fellowship, 1994 & 1995; American Museum of Natural History Research Grant, 1993. Representative & Secretary, MEES Government Organization, 1993-1994; Member, Phi Sigma Honor Society; Member, Animal Behaviour Society; Deans List, University of Idaho.

SELECTED PUBLICATIONS:

Alonzo, J.J. 1997. Role Differentiation, Size Assortative Pairing and Sequential Monogamy in *Cichlasoma nigrofasciatum* (Pisces: Cichlidae; Gunthër) in Lake Xiloá, Nicaragua. *Journal of Aquaculture & Aquatic Sciences*. In press.

Alonzo, J.J. Sexual Selection and Reproductive Success in *Symphodus mediterraneas*, a Mediterranean Wrasse. In prep.

Alonzo, J.J. & R.B. MacFarlane. Smoltification in Chinook Salmon (*Oncorhynchus tshawytscha*) from California's Central Valley. In prep.

CURRICULUM VITAE

NAME: KENNETH A. BALTZ

PRESENT POSITION: Oceanographer, Groundfish Population Analysis Team

EDUCATION: M.S., Physical Oceanography, Naval Postgraduate School, 1997; B.S., Marine Biology, Florida Institute of Technology, 1987.

PAST EXPERIENCE:

1999-2000	Computer Specialist Information Technology Services, NOAA/NMFS Santa Cruz/Tiburon Laboratory
1997-1999	Field Operations Officer NOAA Ship CHAPMAN and NOAA Ship GORDON GUNTER Office of NOAA Corps Operations and NMFS SEFSC Pascagoula, MS
1993-1997	Fisheries Oceanographer (Research and Databases Support) NMFS/SWFSC Tiburon, California (93-95) and Pacific Grove, CA (95-97)
1991-1993	Navigation and Field Operations Officer NOAA Ship Townsend Cromwell Office of NOAA Corps Operations and NMFS SWFSC, Honolulu, HI
1989-1990	Environmental/Ecology Educator and Charter Boat Captain Marine Sciences Under Sails, Hollywood, FL
1987-1989	Animal Trainer for Orcas Sea World of Florida, Orlando, FL

RESEARCH INTERESTS: Information Technologies, Physical Oceanographic Impacts to Fisheries, Air - Sea Interface Dynamics, Pacific Groundfish.

HONORS AND AWARDS: NOAA Special Achievement Awards, 1994 & 1996; Pacific Service Ribbon, 1993; Atlantic Service Ribbon, 1999; Beta Beta Beta Biological Honor Society.

SELECTED PUBLICATIONS:

Baltz, K.B. 1997. Ten years of hydrographic variability off central California during the upwelling season. Naval Postgraduate School Technical Rep., NPS-OC-97-008, 319p.

Schwing, F.B., T.L. Hayward, K.A. Baltz, T. Murphree, K.M. Sakuma, A.S. Mascarenas Jr., A.W. Mantyla, S.I. Castillo, S.L. Cummings, D.G. Ainley, and F. Chavez. 1997. The state of the California Current, 1996-1997: mixed signals from the tropics. CalCOFI Reports, Vol. 38.

Sakuma, K.M., F.B. Schwing, K.A. Baltz, D. Roberts, S. Ralston. 1997. The physical oceanography off the central California coast during May-June, 1996: a summary of CTD data from pelagic juvenile rockfish surveys. U.S. Dept. of Commerce. NOAA-TM-NMFS-SWFSC-246, 155p.

Schwing, F.B., M. O'Farrell, J.M. Steger, K.A. Baltz. 1996. Coastal upwelling indices, west coast of North America, 1946-95. U.S. Dept. of Commerce. NOAA-TM-NMFS-SWFSC-231, 207p.

Sakuma, K.M., F.B. Schwing, K.A. Baltz, D. Roberts, H.A. Parker, S. Ralston. 1996. The physical oceanography off the central California coast during May-June, 1995: a summary of CTD data from pelagic juvenile rockfish surveys. U.S. Dept. of Commerce. NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-232, 144p.

CURRICULUM VITAE

NAME: ERIC P. BJORKSTEDT

PRESENT POSITION: Research Fisheries Biologist, Salmon Population Analysis Team

EDUCATION: Ph.D., Ecology, Stanford University, 1998; Honors B.A., Biology and English, University of Delaware, 1992.

PAST EXPERIENCE: 1998-present Research Fisheries Biologist
NOAA Fisheries, Southwest Fisheries Science Center
Santa Cruz, California

1998 NRC Postdoctoral Research Associate
NOAA Fisheries, Northwest Fisheries Science Center
Seattle, Washington

RESEARCH INTERESTS: Population and metapopulation dynamics of anadromous salmonids; biological and physical processes affecting recruitment and population structure in coastal marine fishes; application of remote sensing in ecological research; life history evolution and behavioral ecology of marine and anadromous fish; theoretical and statistical ecology.

HONORS AND AWARDS: Department of Commerce Bronze Medal, 2000; Performance Award, 2000; National Research Council Postdoctoral Research Associateship, 1998; Excellence in Teaching Award, Department of Biological Sciences, Stanford University, 1995, 1997; Norman K. Wessels Award for Outstanding Performance as a Teaching Assistant, Stanford University, 1994; National Science Foundation Graduate Research Fellowship, 1993; Phi Beta Kappa University of Delaware, 1991.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: ESA Biological Review Team for Klamath Mountain Province steelhead.

SELECTED PUBLICATIONS:

Bjorkstedt, E. P. (2000) DARR (Darroch Analysis with Rank-Reduction): A method for analysis of stratified mark-recapture data from small populations, with application to estimating abundance of smolts from outmigrant trap data. U.S. Dep. Commer., NOAA, NMFS, SWFSC, Admin. Rep., Santa Cruz, SC-00-02. 28 p.

McElhany P., Ruckelshaus M., Ford M. J., Wainwright T., Bjorkstedt E. P. (2000) Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Depart. Commer., NOAA Technical Memorandum NMFS-NWFSC-42, 156 p.

Bjorkstedt, E. (2000) Stock-recruitment relationships for life cycles that exhibit concurrent density dependence. Canadian Journal of Fishery and Aquatic Sciences 57(2): 459-467.

CURRICULUM VITAE

NAME: DAVID A. BOUGHTON

PRESENT POSITION: Research Ecologist, Salmon Population Analysis Team

EDUCATION: Ph.D., Ecology, University of Texas Austin, 1998; A.B. magna cum laude, Ecology and Systematics, Cornell University, 1988.

PAST EXPERIENCE:

2001-present	Research Ecologist NOAA Fisheries, Southwest Fisheries Science Center Santa Cruz, California
1999-2001	Research Ecologist USDA Forest Service, Pacific NW Research Station Corvallis, Oregon
1998-1999	Ecologist US EPA, Office of Research and Development Research Triangle Park, North Carolina
1988-1991	Programmer/Taxonomist Ichthyology, California Academy of Sciences San Francisco, California

RESEARCH INTERESTS: Population and metapopulation dynamics; local adaptation of animal behavior and life history, especially dispersal systems; complex life histories; landscape ecology including interaction of ecological and economic systems. Mathematical ecology, evolution, statistics.

HONORS AND AWARDS: USDA Science Findings Award, 2001. NSF International Postdoctoral Fellowship, 1998. Ecological Society of America Buell Award, 1998 (honorable mention). Sigma Xi, University of Texas, 1997. Annual Symposium Invitee, Environmental Defense Fund, 1997. STAR Fellow, US Environmental Protection Agency, 1996. National Science Foundation, dissertation improvement grant, 1995. University of Texas Austin, continuing fellowship, 1995. National Science Foundation, predoctoral fellowship 1991. Distinction in all subjects, Cornell University (1988)

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: Modelling Workgroup, Survey and Manage Prog. (USDA and BLM), 1999-2000. Chair, Soc. Conserv. Biol., Univ. Texas Chapter 1991-92.

SELECTED PUBLICATIONS:

Boughton, D.A., B.B. Collette & A.R. McCune. 1991. Heterochrony in jaw morphology of needlefishes (Belontiidae: Teleostei). *Systematic Zoology* 40(3): 329 - 354.

Boughton, D.A. 1999. Empirical evidence for source-sink dynamics in a butterfly: Temporal barriers and alternative states. *Ecology* 80(8): 2727 - 2739.

Boughton, D.A. 2000. The dispersal system of a butterfly: a test of source-sink theory suggests the intermediate-scale hypothesis. *American Naturalist* 145: 131 - 144.

Boughton, D.A. & U. Malvadkar. Submitted. Extinction risk in successional landscapes subject to catastrophic disturbances. *Conservation Ecology*.

CURRICULUM VITAE

NAME: HEIDI E. FISH

PRESENT POSITION: Research Fishery Biologist, Salmon Population Analysis Team

EDUCATION: B.S., Zoology, California State University Long Beach, 1983.

PAST EXPERIENCE:

1997-present	Research Fishery Biologist National Marine Fisheries Service Santa Cruz, California
1996	Biological Science Technician National Marine Fisheries Service Tiburon California
1990-1996	Fish and Wildlife Scientific Aide California Department of Fish and Game Long Beach and Menlo Park, California

RESEARCH INTERESTS: Salmon life history and stream survey methods.

HONORS AND AWARDS: Certificate of Recognition, 1997.

PROFESSIONAL AFFILIATIONS: American Fisheries Society

SELECTED PUBLICATIONS:

Laidig, Thomas E., Peter B. Adams, Kelly R. Silberberg and Heidi E. Fish. 1997. Conversions between total, fork and standard lengths for lingcod, *Ophiodon elongatus*. California Fish Game 83:128-129.

Adams, Peter B., Michael J. Bowers, Heidi E. Fish, Thomas E. Laidig and Kelly R. Silberberg. 1999. Historical and Current Presence-Absence Data of Coho Salmon (*Onchorhynchus kisutch*) in the Central California Coast Evolutionarily Significant Unit. U.S. Dep. Commer., NOAA, NMFS, SWFSC Admin. Rep., Tiburon, SC-99-02.

CURRICULUM VITAE

NAME: JOHN CARLOS GARZA

PRESENT POSITION: Research Geneticist, Salmon Ecology Team

EDUCATION: Ph.D., Integrative Biology, University of California, Berkeley, 1998; M.S., Biology, University of California, San Diego, 1991; B.S., Biology, University of California, San Diego, 1990.

PAST EXPERIENCE:

2001-present	Assistant Adjunct Professor of Ocean Sciences University of California, Santa Cruz
2000-present	Research Fellow Institute of Marine Sciences University of California, Santa Cruz
1999-present	Research Geneticist National Marine Fisheries Service Santa Cruz, California
1998-1999	Visiting Scientist Laboratoire Génome et Populations University of Montpellier, France

HONORS AND AWARDS: National Science Foundation Postdoctoral Fellowship, 1998; University of California President's Postdoctoral Fellowship, 1998; National Aeronautical and Space Administration Cooperative Agreement, 1997; Sigma Xi Grant in Aid of Research, 1997; UCB Chancellor's Dissertation Year Fellowship, 1997; Ford Foundation Dissertation Year Fellowship, 1997; National Science Foundation Doctoral Dissertation Improvement Grant, 1996; UCB Vice Chancellor of Research Dissertation Grant, 1996; UCB Mentored Research Award, 1994; UC Natural Reserve System Mildred Mathias Research Grant, 1993; Ford Foundation Predoctoral Fellowship, 1992-96; UCSD Chancellor's Volunteer Award, 1991; Phi Beta Kappa Honor Society, 1989; UCSD Alumni Association: Scholar of the Year (Twice), 1988-90; UCSD Provost's Honor Roll (5 times), 1987-90.

SELECTED PUBLICATIONS:

Garza JC, Williamson E (2001) Detection of reduction in population size using data from microsatellite DNA. *Molecular Ecology* 10: 305-318

Garza JC, Desmarais E (2000) Derivation of a simple microsatellite locus from a compound ancestor in the genus *Mus*. *Mammalian Genome* 11: 1117-1122.

Weber DS, Stewart BS, Garza JC, Lehman N (2000) An empirical genetic assessment of the severity of the northern elephant seal population bottleneck. *Current Biology* 10: 1287-1290 (cover photo).

Garza JC, Dallas J, Duryadi D, Gerasimov S, Croset H, Boursot P (1997) Social structure of the Mound-building mouse, *Mus spicilegus*, revealed by genetic analysis with microsatellites. *Molecular Ecology* 6: 1009-1017 (cover photo).

Garza JC, Freimer NB (1996) Homoplasy for size at microsatellite loci in humans and chimpanzees. *Genome Research* 6: 211-217.

Garza JC, Slatkin M, Freimer NB (1995) Microsatellite allele frequencies in humans and chimps with implications for constraints on allele size. *Molecular Biology and Evolution* 12: 594-603.

Di Rienzo A, Peterson AC, Garza JC, Valdes AM, Slatkin M, Freimer NB (1994) Mutational processes of simple-sequence repeat loci in human populations. *Proceedings of the National Academy of Sciences, USA* 91: 3166-3170.

CURRICULUM VITAE

NAME: CHURCHILL BRAGAW GRIMES

PRESENT POSITION: Director, Santa Cruz Laboratory

EDUCATION: B.S. and M.S. Biology, East Carolina University, Greenville, North Carolina, 1967, 1971; Ph.D., Marine Sciences, University of North Carolina, Chapel Hill, 1976.

PAST EXPERIENCE:

1993-1998	Laboratory Director
1984-1993	Fishery Ecologist National Marine Fisheries Service Panama City, Florida
1983-1984	Associate Professor of Marine Fisheries
1977-1983	Assistant Professor of Marine Fisheries Rutgers University New Brunswick, New Jersey

RESEARCH INTERESTS: Life history, population dynamics, fishery ecology, and recruitment dynamics.

HONORS AND AWARDS: Marine Science Fellowship, University of North Carolina, 1972-1973; Sigma XI; NMFS Outstanding Publication Award, *Fishery Bulletin*, Honorable Mention 1984; Outstanding Performance Award, 1987-1988, 1993-1996; Commendable Performance Award, 1989-1992; NOAA Bronze Medal 1996; American Institute of Fishery Research Biologists: Associate 1975, Member 1980, Fellow 1990; American Fisheries Society: Florida Chapter, Runner-up, Outstanding Presentation at Annual Meeting, February 1992 and 1993; Southern Division, Outstanding Achievement Award, 1996.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: National Center for Ecological Analysis and Synthesis, Open Populations Working Group, 2000-01; MexUS-Pacifico, Coastal Species Working Group Chair, 2000-01; NOAA Science Advisory Board, Science Under Multiple Mandates Panel discussant; Monterey Bay National Marine Sanctuary, Research Activities Panel, 2000-2001; East Carolina University, College of Arts & Science, Advancement Council, 2000-01.

SELECTED PUBLICATIONS:

Allman, R.J. and C.B. Grimes. In press. The temporal and spatial dynamics of spawning settlement and growth of grey snapper, *Lutjanus griseus*, determined using otolith microstructure. *Fish. Bull.*

Grimes, C.B. 2001. Fishery production and the Mississippi River discharge. *Fisheries* 26:17-26.

DeVries, D.A., C.B. Grimes, and M.H. Prager. In press. Using otolith shape analysis to distinguish eastern Gulf of Mexico and Atlantic Ocean stocks of king mackerel. *Fish. Res.*

Livin, P.S. and C.B. Grimes. In press. Conservation and management of grouper. In: P.F. Sale (ed.) *Ecology of coral reef fish*. Academic Press.

Koenig, C.C., F.C. Coleman, C.B. Grimes, G.R. Fitzhugh, C.J. Gledhill, K.M. Scanlon and M. Grace. 2000. Protection of fish spawning habitat for conservation of warm temperate reef fish fisheries on shelf-edge reefs of Florida. *Bull. Mar. Sci.* 116:593-616.

Koenig, C.C., F.C. Coleman, A.M. Eklund and C.B. Grimes. 1999. Management and conservation of temperate reef fishes in the grouper - snapper complex of the southeastern United States. *Proceedings of symposium on Management of Long-lived Species, Trans. Amer. Fish. Soc.* 23:233-242.

Grimes, C. B. and S.C. Turner. 1999. The complex life history of tilefish, *Lopholatilus chamaeleonticeps*, and vulnerability to exploitation. *Proceedings of symposium on Management of Long-lived Species, Trans. Amer. Fish. Soc.* 23:17-26.

CURRICULUM VITAE

NAME: BRIAN M. JARVIS

PRESENT POSITION: Fishery Biologist, Salmon Ecology Team

EDUCATION: B.A., Industrial Arts Interdisciplinary (Electronics-Biology-Geology), San Francisco State University, 1974; A.S., Marine Tech Program, College of Marin, 1972.

PAST EXPERIENCE:

1993-2000	Research Fishery Biologist
1977-1993	Biological Science Technician, Physiological Ecology Branch
1973-1977	Physical Science Technician, Pacific Environmental Group NMFS, Tiburon, California
1975-1977	Oceanographic Technician (part time temp) NORPAX-TRANSPAC program UC San Diego, Scripps Institution of Oceanography Tiburon, California
1966-1969	U. S. Army

RESEARCH INTERESTS: Environmental conditions effecting fish and there viability (reproduction), and survival of the young. Instrumentation for collecting environmental, and biological information within bays, estuaries, near shore and open ocean. Methods of collecting real time data, analyzing it, and its timely dissemination between users i.e. the internet. Using platforms of opportunity, such as the commercial fishing fleet, to collect biological and environmental information.

HONORS AND AWARDS: NMFS, Special Achievement Awards, 1976, 1977, 1994; NMFS, Certificate of Recognition, 1979, 1982-1983, 1988, 1990, 1992-1993, 1994, 1995-1996, 1996-1997, 1998, 2000.

SELECTED PUBLICATIONS:

Eldridge, Maxwell B., and Brian M. Jarvis. 1996. Development and energy utilization in early life stages of viviparous yellowtail rockfish. *In* Don MacKinlay and Maxwell Eldridge (eds.), *The fish egg: Its biology and culture*, p. 131-140. International Congress on the Biology of Fishes, American Fisheries Society, Physiology Section, San Francisco State University, July 14-18, 1996.

Adams, P. B., T. E. Laidig, K. R. Silberberg, M. J. Bowers, B. M. Jarvis, K. M. Sakuma, K. A. Baltz, and D. P. Woodbury. 1996. Historical and current presence-absence data of coho salmon (*Oncorhynchus kisutch*) in the Central California Evolutionary Significant Unit. SWFSC Admin. Rep. Tiburon, T-96-01, 24 p.

Eldridge, M. B., and B. M. Jarvis. 1995. Temporal and spatial variation in fecundity of yellowtail rockfish. *Trans. Am. Fish. Soc.* 124(1):16-25.

Eldridge, M. B., J. A. Whipple, M. J. Bowers, B. M. Jarvis, and J. Gold. 1991. Reproductive performance of yellowtail rockfish, *Sebastes flavidus*. *Environ. Biol. Fishes* 30: 91-102.

Chess, J., E. Hobson, D. Howard, B. Jarvis, C. Reilly, and W. Samiere. 1989. Biota of a shallow estuarine habitat in San Francisco Bay. U. S. Dep. Commer., NOAA, NMFS, SWFC Admin. Rep., Tiburon, T-89-02, 23 p.

Eldridge, Maxwell B., Jeannette A. Whipple, Dana Eng, Michael J. Bowers, and Brian M. Jarvis. 1981. Effects of food and feeding factors on laboratory-reared striped bass larvae. *Trans. Am. Fish. Soc.* 110(1):111-120.

Whipple, Jeannette, Maxwell Eldridge, Pete Benville, Michael Bowers, Brian Jarvis, and Nancy Stapp. 1981. The effect of inherent parental factors on gamete condition and viability in striped bass (*Morone saxatilis*). *Rapp. P.-V. Reun. Cons. Int. Explor. Mer* 178:93-94.

CURRICULUM VITAE

NAME: RACHEL C. JOHNSON

PRESENT POSITION: Research Fishery Biologist, Salmon Ecology Team - Student Career Experience Program

EDUCATION: Ph.D. candidate, Ecology and Evolutionary Biology, University of California, Santa Cruz; B.A., Biology, Wellesley College, Massachusetts, 1997.

PAST EXPERIENCE:	1999-present	Graduate Researcher
	1999-2000	Teaching Assistant University of California, Santa Cruz
	1998	Zooplankton Identification Specialist SWFSC Antarctic Marine Living Resources Group South Shetland Islands, Antarctica
	1998	Taxonomist California Academy of Sciences San Francisco, California
	1997	Tropical Marine Ecologist/ Instructor International Zoological Expedition Belize, Central America
	1995-1997	Marine Biology Teaching Assistant Wellesley College, Massachusetts

RESEARCH INTERESTS: Applied marine ecology, population biology, fishery ecology, metapopulation dynamics, and application of stable isotopes as tracers of spatial structure in populations.

HONORS AND AWARDS: Myers Oceanographic and Marine Biology Scholarship, 2001; Honorable Mention, NSF Graduate Research Fellowship, 1998 & 1999.

SELECTED PUBLICATIONS:

Jensen, G.C. and R.C. Johnson. 1999. Reinstatement and further description of *Eualus subtilis* Carvacho & Olsen, and comparison with *E. lineatus* Wicksten & Butler (Crustacea: Decapoda: Hippolytidae). *Proceeding of the Biological Society of Washington* 112(1): 133-140.

Loeb, V., R.C. Johnson and E. Linen. (In Prep). Distribution of krill, salp and other zooplankton taxa around Elephant Island during the 1998 Austral summer. *Antarctic Journal*.

Johnson, R.C., Grimes, C.B. and C.F. Royer. (In Prep). Discrimination of hatchery and wild chinook salmon (*Oncorhynchus tshawysha*) in the California Central Valley using otolith microstructure.

Johnson, R.C., and R.B. MacFarlane. (In Prep). Estuary use and growth history of juvenile Chinook salmon from the California Central Valley juvenile in the San Francisco Bay Estuary.

CURRICULUM VITAE

NAME: THOMAS E. LAIDIG

PRESENT POSITION: Research Fishery Biologist, Habitat Ecology Team

EDUCATION: M.A., Marine Biology, San Francisco State University, 1987; B.A., Aquatic Biology, University of California, Santa Barbara, 1983.

PAST EXPERIENCE:

1990-present	Research Fishery Biologist NMFS/SWFSC Santa Cruz and Tiburon, California
1989-1990	Biological Technician NMFS/SWFSC Tiburon, California
1988-1989	Biological Aid NMFS/SWFSC Tiburon, California

RESEARCH INTERESTS: Population dynamics, age and growth of fishes, salmonid life history and estuary residence times, video stock assessment, species identification, kelp bed ecosystems, and rockfish recruitment dynamics.

HONORS AND AWARDS: Certificates of Recognition, NMFS: Sustained Superior Performance Award, 1989, 1990, 1994.

SELECTED PUBLICATIONS:

Laidig, Thomas E., Kelly R. Silberberg, and Peter B. Adams. 2001. Validation of the first, second, and third annulus from the dorsal fin rays of lingcod (*Ophiodon elongatus*). NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-306, 19 p.

Laidig, Thomas E. In Press. Deep slope fishes. In Gulf of the Farallones Atlas, sponsored by the USGS.

Silberberg, Kelly R., Thomas E. Laidig, Peter B. Adams, and Douglas Albin. In press. Analysis of maturity in lingcod (*Ophiodon elongatus*). Cal. Fish Game.

Adams, Peter B., Erik Williams, Kelly R. Silberberg, and Thomas E. Laidig. 1999. Southern lingcod stock assessment in 1999. 53 p.

Laidig, Thomas E., and Keith M. Sakuma. 1998. Description of pelagic larval and juvenile grass rockfish, *Sebastes rastrelliger* (Family Scorpaenidae), with an examination of age and growth. Fish. Bull. 96(4):788-796.

Jagiello, Thomas, Peter Adams, Martin Peoples, Sandra Rosenfield, Kelly Silberberg, and Tom Laidig. 1997. Assessment of lingcod in 1997. Appendix: Status of the Pacific coast groundfish fishery through 1997 and recommended acceptable biological catches for 1998. Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 224, Portland, OR 97201. 85 p.

CURRICULUM VITAE

NAME: STEVEN T. LINDLEY

PRESENT POSITION: Ecologist, Salmon Population Analysis Team

EDUCATION: Ph.D., Duke University, 1994; B.A., Aquatic Biology, with Honors and Distinction, University of California, Santa Barbara, 1989.

PAST EXPERIENCE:

1996-present	Ecologist NMFS/SWFSC Santa Cruz/Tiburon Laboratory
1995-1996	Research Associate Marine Laboratory, Duke University Beaufort, North Carolina
1994-1995	Postdoctoral Fellow Stanford University and Carnegie Institution of Washington Stanford, California

RESEARCH INTERESTS: Population biology, ecosystem ecology, numerical and statistical modeling, biological oceanography, application of stable isotopes as tracers of ecological processes.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: Central Valley Salmonid Recovery Team (Chair), NMFS; Chinook Status Review and Biological Review Teams, NMFS; Winter Run Project Work Team, Interagency Ecological Program.

SELECTED PUBLICATIONS:

Lindley, S. T., M. S. Mohr and M. H. Prager. 2000. Monitoring protocol for Sacramento River winter chinook salmon: application of statistical power analysis to recovery of an endangered species. *Fishery Bulletin* 98: 759–766.

Brodeur, R. D., G. W. Boehlert, E. Casillas, M. B. Eldridge, J. H. Helle, W. T. Peterson, W. R. Heard, S. Lindley and M. H. Schiewe. 2000. A coordinated research plan for estuarine and ocean research on Pacific salmon. *Fisheries* 25: 7–16.

Chai, F., S. T. Lindley, J. R. Toggweiler, and R. T. Barber. 2000. Testing the importance of iron and grazing in the maintenance of the high nitrate condition in the equatorial Pacific Ocean: a physical-biological model study. In: *The Changing Ocean Carbon Cycle: a midterm synthesis of the Joint Global Ocean Flux Study*. R. B. Hanson, H. W. Ducklow, and J. G. Field (eds). International Geosphere-Biosphere Programme Book Series 5. Cambridge University Press.

Bender, M., J. Orchardo, M. Dickson, R. Barber and S. Lindley. 1999. In vitro O₂ fluxes compared with ¹⁴C production and other rate terms during the JGOFS Equatorial Pacific experiment. *Deep Sea Research* 46: 637–654.

Lindley, S. T. and R. T. Barber. 1998. Phytoplankton response to natural and experimental iron enrichment. *Deep Sea Research*. 45: 1135–1150.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U. S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

CURRICULUM VITAE

NAME: ALEC D. MacCALL

PRESENT POSITION: Supervisor, Groundfish Analysis Team

EDUCATION: Ph.D., Oceanography, Scripps Institution of Oceanography, University of California at San Diego, 1983; M.A., Biology, California State University at Long Beach, 1979; .B.A., Biology (with Distinction), University of Rochester, Rochester, New York 1969.

PAST EXPERIENCE:

1997 - 2000	Chief, Groundfish Analysis Branch
1988 - 1997	Director, NMFS/SWFSC/Tiburon Laboratory
1982 - 1988	Fishery Biologist (Research) NMFS/SWFSC, La Jolla, California
1974 - 1982	Marine Biologist (At separation - Senior Marine Biologist) California Department of Fish and Game c/o National Marine Fisheries Service La Jolla, California
1986 - 1990	Adjunct Assistant Professor of Oceanography Scripps Institution of Oceanography, UCSD

RESEARCH INTERESTS: Population dynamics, ecology of fisheries, low frequency environmental variability, design of fishery management strategies.

HONORS AND AWARDS: California Department of Fish and Game Director's Award, 1978; Research Fellowship, Sea Fisheries Research Institute, Department of Agriculture and Fisheries, Republic of South Africa, 1982; Washington Sea Grant Lecturer in Recruitment Oceanography, 1986.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: Pacific Fishery Management Council: Northern Anchovy Plan Development Team, 1976-1988, Jack Mackerel Plan Development Team, 1978-1981, Scientific and Statistical Committee, 1988-1995, Groundfish Management Team, 1998-present. California Sea Grant: California Sea Grant Committee, Member, 1988-1990. Pacific Seabird Group: Committee on Seabird-Fishery Interactions, Member, 1978-1985, Chairman, 1986-1991.

SELECTED PUBLICATIONS:

MacCall, Alec D. 2001. In press. Fishery management and stock rebuilding prospects under conditions of low frequency environmental variability and species interactions. *Bull. Mar. Sci.*

MacCall, Alec D. 2001. In press. Use of known-biomass production models to determine productivity of west coast groundfish stocks. *N. Am. J. Fish. Mgmt.*

MacCall, Alec D. 2001 In press. [Book review] Quantitative fish dynamics. *J. Am. Stat. Assn.*

MacCall, Alec D., And Stephen Ralston. 2001. In press. Is logarithmic transformation really the best procedure for estimating stock-recruitment relationships? *N. Am. J. Fish. Mgmt.*

MacCall, Alec D, and Thomas C. Wainwright (editors). 2001. In prep. Assessing extinction risk for West Coast salmon: Proceedings of the workshop. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-??.

Stephen Ralston, Alec D. MacCall and Donald E. Pearson. The status of black rockfish (*Sebastes melanops*) off Oregon and California in 2001. *In* Status of the Pacific Coast Groundfish Fishery Through 2001 and Recommended Acceptable Biological Catches for 2002, Stock Assessment and Fishery Evaluation, Appendix. Pacific Fishery Management Council, 2130 SW Fifth Ave., Suite 224, Portland, Oregon, 97201.

CURRICULUM VITAE

NAME: MICHAEL S. MOHR

PRESENT POSITION: Team Leader, Salmon Population Analysis

EDUCATION: Graduate study, Biostatistics, University of California, Berkeley, California; M.S., Fisheries, Humboldt State University, Arcata, California, 1986; B.A., Mathematics, Humboldt State University, 1983; B.S., Fisheries, Humboldt State University, 1980.

PAST EXPERIENCE:

1996-present	Mathematical Statistician National Marine Fisheries Service Southwest Fisheries Science Center Santa Cruz, California
1994-1995	Statistical Consultant California Department of Fish and Game Ofc. of Oil Spill Prevention and Response Sacramento, California
1994	Visiting Assistant Professor Humboldt State University Departments of Mathematics and Fisheries Arcata, California

RESEARCH INTERESTS: Estimator development, population dynamics, stock assessment, fishery management under uncertainty.

HONORS AND AWARDS: Outstanding Performance Award, NMFS, 1999. Special Act, NMFS, 1999. Special Act, NMFS, 1999. High Level of Performance, NMFS, 1997.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: Salmon Technical Team, Pacific Fishery Management Council, 1997-present; Klamath River Technical Advisory Team, Klamath Fishery Management Council, 1997-present; Coho Salmon Biological Review Team, NMFS, 1996-1997; Mass Mark Working Group, NMFS, 1996-1997.

SELECTED PUBLICATIONS:

Grover, Allen M., Michael S. Mohr, and Melodie L. Palmer-Zwahlen. *In Press*. Hook-and-release mortality of chinook salmon from drift mooching with circle hooks: management implications for California's ocean sport fishery. National symposium on catch and release in marine recreational fisheries. American Fisheries Society, Special Publication Series.

Prager, Michael H., and Michael S. Mohr. 2001. The harvest rate model for Klamath River fall chinook salmon, with management applications and comments on model development and documentation. *North American Journal of Fisheries Management* 21:533-547.

Norton, E. C., R. B. MacFarlane, and M. S. Mohr. 2001. Lipid class dynamics during development in early life stages of shortbelly rockfish and their application to condition assessment. *Journal of Fish Biology* 58:1010-1024.

Lindley, Steven, T., Michael S. Mohr, and Michael H. Prager. 2000. Monitoring protocol for Sacramento River winter chinook salmon, *Oncorhynchus tshawytscha*: application of statistical power analysis to recovery of an endangered species. *Fishery Bulletin* 98:759-766.

Mohr, Michael S., and David G. Hankin. 1989. Estimation of size-specific molting probabilities in adult decapod crustaceans based on postmolt indicator data. *Canadian Journal of Fisheries and Aquatic Sciences* 46:1819-1830.

CURRICULUM VITAE

NAME: ELIZABETH C. NORTON

PRESENT POSITION: Research Fishery Biologist, Salmon Ecology Team

EDUCATION: B.A., Aquatic Biology, University of California, Santa Barbara, 1983.

PAST EXPERIENCE:

1990-present	Research Fishery Biologist NMFS/SWFSC Santa Cruz and Tiburon, California
1987-1990	Biological Technician NMFS/ SWFSC Tiburon, California
1985-1987	Educational Sales Representative, Portland, Oregon
1984	Foreign Fisheries Observer - 3 Bering Sea Tours NMFS Alaska Region Seattle, Washington

RESEARCH INTERESTS: Salmon feeding ecology, zooplankton ecology, larval fish condition.

VOLUNTEER ACTIVITIES: Docent, California Academy of Sciences, San Francisco, 1992-1996; Lecturer, "Expanding Your Horizons," Skyline College, San Bruno, CA 1990, 1992; Discovery Day, Romberg Tiburon Center for Environmental Studies, San Francisco State University, Tiburon, CA 1989-1996; UCSB Research Assistant, Scripps Institute of Oceanography, CALCOFI and NMFS research cruises, 1983.

HONORS AND AWARDS: Chancellor's Scholar, UCSB, 1979; NOAA Performance Awards, 1993, 1994, 1995, 1996, 2000.

SELECTED SERVICE ON COMMITTEES: Southwest Region Equal Employment Opportunity Advisory Committee, Personnel Subcommittee Chair, 2000-2002.

SELECTED PUBLICATIONS:

Norton, E. C., R. B. MacFarlane, and M. S. Mohr. 2001. Lipid class dynamics during development in early life stages of shortbelly rockfish (*Sebastes jordani*) and their application to condition assessment. *J. Fish Biol.* 58, 1010-1024.

MacFarlane, R. B., and E. C. Norton. 2001. Physiological ecology of juvenile chinook salmon (*Onchorhynchus tshawytscha*) at the southern end of their distribution, the San Francisco Estuary and Gulf of the Farallones, California. *Fish. Bull.*, U.S. In press.

Norton, E. C., and R. B. MacFarlane. 1999. Lipid class composition of the viviparous yellowtail rockfish (*Sebastes flavidus*) over the reproductive cycle. *J. Fish Biol.* 54:1287-1299.

MacFarlane, R. B., and E. C. Norton. 1999. Nutritional dynamics during embryonic development in the viviparous genus *Sebastes* and their application to the assessment of reproductive success. *Fish. Bull.*, U.S. 97:273-281.

MacFarlane, R. B., and E. C. Norton. 1996. Lipid and protein changes during embryo development in the viviparous genus *Sebastes*: Application to the assessment of reproductive success. *In* Don MacKinlay and Maxwell Eldridge (eds.), *The fish egg: Its biology and culture*, p. 95-102. International Congress on the Biology of Fishes, American Fisheries Society, Physiology Section, San Francisco State University, July 14-18, 1996.

Norton, E. C., and R. B. MacFarlane. 1995. Nutritional dynamics of reproduction in viviparous yellowtail rockfish (*Sebastes flavidus*). *Fish. Bull.*, U.S. 93:299-307.

CURRICULUM VITAE

NAME: DONALD E. PEARSON

PRESENT POSITION: Fishery Biologist, Groundfish Population Analysis Team

EDUCATION: M.S., Biology, University of the Pacific, 1985; B.S., Ecology, San Jose State University, 1980.

PAST EXPERIENCE:

1987-present	Fishery Biologist, Fishery Technician NMFS/ SWFSC Santa Cruz and Tiburon Laboratories
1986-1987	Biological Technician California Department of Fish and Game Menlo Park, California
1983-1985	Graduate Assistant University of the Pacific Stockton, California
1979-1981	Biologist Marine Ecological Institute Redwood City, California

RESEARCH INTERESTS: Stock assessment, estuarine biology, and population ecology.

HONORS AND AWARDS: NOAA Certificates of Recognition, 1993, 1994; NOAA Sustained Outstanding Performance Award, 1990; Honorable Mention Best Publication, Fisheries Bulletin, 1989; NOAA Special Achievement Award, 1987.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: Groundfish Management Team member, 1991-1993; Applications Target Architecture Team member, 1997-1998.

SELECTED PUBLICATIONS:

Pearson, Donald E. Data availability, landings, and length trends of California's rockfish. U.S. Dept. Comm. Admin. Rpt. SC-00-01. March 2000. 94pp.

Pearson, Donald E., and Brenda Erwin. 1997. Documentation of California's commercial market sampling data entry and expansion programs. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-240, 62 p.

Pearson, Donald E. 1996. Timing of hyaline-zone formation as related to sex, location, and year of capture in otoliths of the widow rockfish *Sebastes entomelas*. Fish. Bull., U.S. 94:190-197.

Pearson, Donald E. 1994. An initial examination of the status of the bank rockfish fishery off the coast of California. Appendix E. In Status of the Pacific Coast Groundfish Fishery through 1994 and recommended acceptable biological catches for 1995. Pacific Fishery Management Council, Portland, Oregon.

Pearson, Donald E., David A. Douglas, and Bill Barss. 1993. Biological observations from the Cobb Seamount rockfish fishery. Fish. Bull., U. S. 91(3):573-576.

Pearson, Donald E., and Joseph E. Hightower. 1991. Spatial and temporal variability in growth of widow rockfish (*Sebastes entomelas*). U. S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-167, 43 p.

Pearson, Donald E., Joseph E. Hightower and Jacqueline T. H. Chan. 1991. Age, growth, and potential yield for shortbelly rockfish *Sebastes jordani*. Fish. Bull., U. S. 89(3):403-409.

CURRICULUM VITAE

NAME: STEPHEN VAN DYKE RALSTON

PRESENT POSITION: Research Fishery Biologist, Groundfish Population Analysis Team

EDUCATION: Ph.D., Fisheries, University of Washington, Seattle, 1981; M.S., Zoology, University of Hawaii, Honolulu, 1975; B.A., Zoology, University of California, Los Angeles, 1971.

PAST EXPERIENCE:

1988-present	Research Fisheries Biologist NMFS/SWFSC Santa Cruz and Tiburon California
1986-1988	Task Leader, Insular Stock-Assessment NMFS/SWFSC Honolulu, Hawaii
1978-1982	Fishery Biologist Fisheries Research Institute, University of Washington Seattle, Washington

RESEARCH INTERESTS: Fisheries population dynamics, stock assessment, age and growth of fishes, recruitment processes, fishery oceanography.

HONORS AND AWARDS: Honolulu Laboratory Nominee for Manager of the Year, 1986; NMFS Publications Advisory Committee Honorable Mention for best publication in U.S. Fishery Bulletin, 1984, 1985, 1986.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: Scientific and Statistical Committee, Pacific Fishery Management Council, 1999-present; Groundfish Management Team, Pacific Fishery Management Council, 1995-1997; External Examiner on Ph.D. Dissertation of Mr. Stephen J. Newman, University of North Queensland, Australia, 1995; Master's Thesis Committee, U.S. Naval Postgraduate School, Monterey, California, 1998; Master's Thesis Committees, California State University, San Francisco, 1991, 1992, 1996, 1998-present; Master's and Doctoral Thesis Committees, University of Hawaii, Honolulu, 1984-1986, 1989; Bottomfish/Seamount Plan Development and Monitoring Teams, Western Pacific Fishery Management Council, 1979-1988.

SELECTED PUBLICATIONS:

Ralston, S., W. H. Lenarz, and D. P. Woodbury. In prep. Long-term variability in year-class strength of northern California rockfishes (*Sebastes* spp.) in relation to the larval ocean environment and young-of-the-year growth. Fish. Oceanogr.

Williams, E. H., and S. Ralston. In review. Distribution and co-occurrence of rockfish (Family Scorpaenidae) in the waters off southern Oregon and California. U. S. Fish. Bull.

Rau, G. H., S. Ralston, J. R. Southon, and F. P. Chavez. In press. Upwelling, diet, and the condition of juvenile rockfish: a study using ¹⁴C, ¹³C, and ¹⁵N natural abundances. Limn. and Oceanogr.

Ralston, S., J. R. Bence, M. B. Eldridge, and W. H. Lenarz. In review. An approach to estimating the spawning biomass of rockfish using a larval production method with application to *Sebastes jordani*. Submitted to U. S. Fishery Bulletin.

MacCall, A. D., and S. Ralston. In press. Erratic performance of logarithmic transformation in estimation of stock-recruitment relationships. N. Amer. J. Fish. Manag.

Ralston, S., and J. N. Ianelli. 1998. When lengths are better than ages: the complex case of bocaccio, pp. 451-468. In: F. Funk, T. J. Quinn, II, J. Heifetz, J. N. Ianelli, J. E. Powers, J. F. Schweigert, P. J. Sullivan, and C.-I. Zhang (eds.), Fishery Stock Assessment Models, Univ. Alaska Sea Grant College Program, AK-SG-98-01.

CURRICULUM VITAE

NAME: DALE A. ROBERTS

PRESENT POSITION: Research Fishery Biologist, Groundfish Population Analysis Team

EDUCATION: M.A., Marine Biology, San Francisco State University, 1979; B.S., Conservation of Natural Resources, University of California, Berkeley, 1974.

PAST EXPERIENCE:

1991-Present	Fishery Biologist NMFS/SWFSC Santa Cruz/Tiburon Laboratory
1988-1991	Environmental Scientist Environmental Technology Group Science Applications International Corporation
1980-1988	Research Associate/Programmer Marine Science Institute University of California, Santa Barbara
1977-1980	Research Assistant Department of Structural Biology Stanford University

RESEARCH INTERESTS: Fishery biology, fish ecology, statistical computing, responses of marine populations to natural (El Niño, upwelling) and man-caused (power plants, dredge material) disturbances, and techniques for accurately censusing fish populations.

SELECTED PUBLICATIONS:

Sakuma, K. M., S. Ralston and D. A. Roberts. 1999. Diel vertical distribution of postflexion larval *Citharichthys* spp. and *Sebastes* spp. off Central California. *Fish. Oceanogr.*,8:(1)68-76.

Ralston, Stephen, Edward B. Brothers, Dale A. Roberts, and Keith M. Sakuma. 1996. Accuracy of age estimates for larval *Sebastes jordani*. *Fish. Bull.*, U.S. 94:89-97.

DeMartini, E. E., and D. A. Roberts. 1990. Effects of giant kelp (*Macrocystis*) on the density and abundance of fishes in a cobble-bottom kelp forest. *Bull. Mar. Sci.* 46:287-300.

DeMartini, E. E., D. A. Roberts, and T. W. Anderson. 1989. Contrasting patterns of fish density and abundance at an artificial rock reef and a cobble-bottom kelp forest. *Bull. Mar. Sci.* 44:881-892.

Anderson, T. W., E. E. DeMartini, and D. A. Roberts. 1989. The relationship between habitat structure, body size and distribution of fishes at a temperate artificial reef. *Bull. Mar. Sci.* 44:681-697.

DeMartini, E. E., L. G. Allen, R. K. Fountain, and D. Roberts. 1985. Diel and depth variations in the sex-specific abundance, size-composition, and food habits of queenfish, *Seriophus politus*. *Fish. Bull.*, U. S. 83:171-185.

Hallacher, L. E., and D. A. Roberts. 1985. Differential utilization of space and food by the inshore rockfishes (Scorpaenidae: *Sebastes*) of Carmel Bay, California. *Environ. Biol. Fishes* 12:93-110.

Roberts, D., E. E. DeMartini, and K. M. Plummer. 1984. The feeding habits of juvenile-small adult barred sand bass (*Paralabrax nebulifer*) in nearshore waters off northern San Diego County. *Calif. Coop. Oceanic Fish. Invest. Rep.* 25:105-111.

CURRICULUM VITAE

NAME: KEITH M. SAKUMA

PRESENT POSITION: Research Fishery Biologist, Groundfish Population Analysis Team

EDUCATION: M.A., Marine Biology, San Francisco State University, 1992; B.A., Zoology, University of Hawaii, Manoa, 1987.

PAST EXPERIENCE:

1992-present	Research Fishery Biologist NMFS/SWFSC Santa Cruz and Tiburon, California
1991-1992	Student Trainee in Biological Sciences NMFS/SWFSC Tiburon, California
1989-1992	Teaching Assistant/Graduate Assistant San Francisco State University San Francisco, California
1985-1989	Fishery Aide State of Hawaii Division of Aquatic Resources Honolulu, Hawaii

RESEARCH INTERESTS: Fisheries oceanography, age and growth of larval and juvenile fish, larval fish taxonomy, and population dynamics.

HONORS AND AWARDS: Outstanding Performance Rating, 1993, 1995, 1997; Commendable Performance 1992, 1994.

SELECTED PUBLICATIONS:

Sakuma, K.M., F.B. Schwing, M.H. Pickett, D. Roberts, and S. Ralston. 2000. The physical oceanography off the central California coast during May-June, 1998: a summary of CTD data from pelagic juvenile rockfish surveys. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-297, 78 pp.

Sakuma, K.M., S. Ralston, and D.A. Roberts. 1999. Diel vertical distribution of post-flexion larval *Citharichthys* spp. and *Sebastes* spp. off central California. Fisheries Oceanogr. 8:68-76.

Sakuma, K.M., S. Ralston, W.H. Lenarz, and M. Embury. 1999. Effects of the parasitic copepod *Cardiodectes Medusaeus* on the lanternfishes *Diaphus theta* and *Tarletonbeania crenularis* off central California. Environ. Biol. Fishes 55:423-430.

Sakuma, K.M., and S. Ralston. 1997. Vertical and horizontal distribution of juvenile Pacific whiting (*Merluccius productus*) in relation to hydrography off California. Calif. Coop. Oceanic Fish. Invest. Rep. 38:137-146.

Sakuma, Keith M., and Thomas E. Laidig. 1995. Description of larval and pelagic juvenile chilipepper, *Sebastes goodei* (family Scorpaenidae), with an examination of larval growth. Fish. Bull. 93:721-731.

Sakuma, Keith M., and Stephen Ralston. 1995. Distributional patterns of late larval groundfish off central California in relation to hydrographic features during 1992 and 1993. Calif. Coop. Oceanic Fish. Invest. Rep. 36:179-192.

Sakuma, Keith M., and Ralph J. Larson. 1995. Distribution of pelagic metamorphic-stage sanddabs *Citharichthys sordidus* and *C. stigmaeus* within areas of upwelling off central California. Fish. Bull. 93:516-529.

CURRICULUM VITAE

NAME: BRIAN C. SPENCE

PRESENT POSITION: Research Fishery Biologist, Salmon Population Analysis Team

EDUCATION: Ph.D., Fisheries Science, Oregon State University, 1995; M.S., Natural Resources (Fishery Science), Cornell University, 1989; B.S., Wildlife and Fisheries Biology, University of California, Davis, 1983.

PAST EXPERIENCE:

2000-present	Research Fishery Biologist National Marine Fisheries Service Santa Cruz, California
1998-2000	Visiting Faculty, Environmental Studies The Evergreen State College, Olympia, Washington
1996-1997	Consultant, Aquatic Ecologist Umpqua Land Exchange Project Corvallis, Oregon
1995-1996	Project Scientist, Fisheries ManTech Environmental Research Services Corporation Corvallis, Oregon
1990-1995	Graduate Research/Teaching Assistant Department of Fisheries and Wildlife Oregon State University, Corvallis, Oregon

RESEARCH INTERESTS: Life-history variation in Pacific salmonids; salmonid habitat relationships; effects of human perturbations on aquatic ecosystems; conservation biology of resident and anadromous fishes.

PROFESSIONAL AFFILIATIONS: American Fisheries Society; Society for Conservation Biology.

SERVICE ON SCIENTIFIC COMMITTEES: Current member of Technical Recovery Team for listed salmonids in the North Central California Coast Domain.

PUBLICATIONS:

Spence, B. C., T. H. Williams, E. P. Bjorkstedt, and P. B. Adams. 2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA.

Hobbs, S. H., R. L. Beschta, E. D. Clark, W. Dennison, J. Gabriel, S. Garman, R. Gill, S. Gregory, R. Jones, W. McComb, A. McKee, K. Pollett, W. Ripple, J. Sessions, B. C. Spence, D. Vesely, and D. Wagner. 1998. Pilot study report: Umpqua Land Exchange Project. World Forestry Center, Portland, OR. 170 p. + appendices.

Spence, B. C., G. A. Lomnický, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corporation, Corvallis, OR. 356 p.

Spence, B. C. 1995. Geographic variation in timing of fry emergence and smolt migration in coho salmon (*Oncorhynchus kisutch*). Ph.D. thesis, Oregon State University, Corvallis, OR. 201 p.

Gucinski, H., R. T. Lackey, and B. C. Spence. 1991. Global climate change: Policy implications for fisheries. Fisheries 15(6):33-38.

Spence, B. C. 1989. Effects of temperature, food availability and social dominance on microhabitat selection by steelhead and rainbow trout (*Oncorhynchus mykiss*). M.S. thesis, Cornell University, Ithaca, NY. 83 p.

CURRICULUM VITAE

NAME: CYNTHIA J. THOMSON

PRESENT POSITION: Economist, Fisheries Branch

EDUCATION: M.A., Economics, University of California, San Diego, 1977; B.A., Sociology, University of California, San Diego, 1972.

PAST EXPERIENCE:	1996-present	Economist NMFS/SWFSC Santa Cruz, California
	1978-1996	Economist NMFS/SWFSC La Jolla, California
	1975-1977	Teaching Assistant, Department of Economics University of California, San Diego La Jolla, California
	1974	Research Assistant - Sea Grant Project

RESEARCH INTERESTS: Fishery management, non-market valuation, salmon habitat restoration cost estimation, design of fishery economic surveys, economics of marine protected areas.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: Pacific Fishery Management Council, Scientific and Statistical Committee, 1991-present, vice chair 1997-1998, chair 1999-present; RecFIN Committee, 1996-present; State of California Squid Research Scientific Committee, 1999-2001; NOAA Superfund Litigation Team, 1993-1996; Central Valley Project Improvement Act Environmental Team, 1994-1995; Pacific Fishery Management Council, Coastal Pelagics Plan Development Team, 1991-1994; Pacific Fishery Management Council, Anchovy Plan Development Team, 1989-1991.

SELECTED PUBLICATIONS:

Thomson, C.J. In press. The human ecosystem. In: Leet, W. et al. (eds.). *California's Living Marine Resources: A Status Report*. California Department of Fish and Game.

Thomson, C.J. et al. 2000. *Overcapitalization in the West Coast Groundfish Fishery: Background, Issues and Solutions*. Prepared for the Pacific Fishery Management Council by the Scientific and Statistical Committee, Economics Subcommittee. 116 p.

Thomson, C.J. 1999. Economic and implications of no-take reserves: an application to *sebastes* rockfish in California. *Calif. Coop. Oceanic Fish. Invest. Rep.* 40:107-117.

Thomson, C. 1998. Evaluating marine harvest refugia: an economic perspective. In: Yoklavich, Mary (ed.). *Marine Harvest Refugia for West Coast Rockfish: A Workshop*. U.S. Dep. Commer., NOAA Tech Memo, NOAA-TM-NMFS-SWFSC-255.

Thomson, C. 1997. Analysis of agency costs attributable to the Recovery Plan for Sacramento River winter-run chinook salmon. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-249.

Kling, C.L. and C.J. Thomson. 1996. The implications of model specification for welfare estimation in nested logit models. *American Journal of Agricultural Economics*. 78:103-114.

Thomson, C.J. 1996. Alaskan recreational harvest sector. In: *Our Living Oceans. The economic status of U.S. fisheries, 1996*. U.S. Dep. Commer., NOAA Tech.Memo. NMFS F/SPO-22.

CURRICULUM VITAE

NAME: DAVID TOMBERLIN

PRESENT POSITION: Economist, Fisheries Branch

EDUCATION: Ph.D., Forest Economics, University of Wisconsin - Madison, 1999; M.S., Agricultural and Resource Economics, North Carolina State University, Raleigh, 1993; B.A., English and Creative Writing, Princeton, New Jersey, 1988.

PAST EXPERIENCE:	1999-present	Economist NMFS/ SWFSC Santa Cruz, California
	1993-1999	Research Assistant Department of Forestry, University of Wisconsin
	1998	Economics Consultant Food and Agriculture Organization, Rome, Italy
	1992-1993	Research Assistant North Carolina State University, Raleigh, North Carolina
	1988-1990	Lecturer Universitas Bung Hatta, Padang, Indonesia

RESEARCH INTERESTS: Regulatory impact analysis, resource policy formulation under uncertainty, real options analysis in public policy, bioeconomic modeling, economics of stock assessment.

HONORS AND AWARDS: McGovern Scholar, 1997, 1998; USDA National Research Initiative grantee, 1994, 1998; Center for Southeast Asian Studies Fellow, 1995; Magna Cum Laude, Phi Beta Kappa, 1988;

SELECTED PUBLICATIONS:

Tomberlin, D. "Modeling California Salmon Fleet Dynamics." In Proceedings of the 2001 North American Association of Fisheries Economists meeting, April 2-4. Forthcoming.

Tomberlin, D. "The Allocation Problem in Habitat Restoration." In Proceedings of the Habitat Restoration Cost workshop, Gladstone, OR, October 2000. Forthcoming.

Tomberlin, D., and J. Buongiorno. "Timber Plantations, Timber Supply, and Forest Conservation." In Mati Palo, ed., World Forests, Markets, and Policies. Kluwer Academic Publishers. Forthcoming.

Tomberlin, D. "Real Options Analysis of Entry and Exit in Fisheries." Presented to the NMFS economists' national meeting, La Jolla, February 2000.

Tomberlin, D., J. Buongiorno, and D. Brooks. "Trade, Forestry, and the Environment: Issues and Methods." *Journal of Forest Economics* 4(3):177-206. Fall 1998.

Tomberlin, D., J. Buongiorno, and S. Zhu. "ASIAPAC: A Model of Consumption, Production, and Trade in the Asia-Pacific Forest Sector." FAO Forest Sector Background Paper. 1998.

CURRICULUM VITAE

NAME: THOMAS H. WILLIAMS

PRESENT POSITION: Research Fishery Biologist, Salmon Population Analysis Team

EDUCATION: Ph.D. candidate, Fisheries Science, Oregon State University; M.S., Fish and Wildlife Management, Montana State University, Bozeman, 1990; B.S., Fisheries, Humboldt State University, 1985.

PAST EXPERIENCE:

1998 - present	Research Fishery Biologist, NMFS Santa Cruz, California
1992 - 1998	Graduate Research/Teaching Assistant Department of Fisheries and Wildlife Oregon State University, Corvallis, Oregon
1991 - 1992	Research Assistant, Oregon Cooperative Wildlife Research Unit Staff member - Northern Spotted Owl Recovery Team Oregon State University, Corvallis, Oregon

RESEARCH INTERESTS: Ecology of Pacific salmonids and relations among marine, freshwater, and terrestrial communities; conservation biology and conservation genetics related to conservation of Pacific salmon and trout.

PROFESSIONAL AFFILIATIONS: American Fisheries Society, Ecological Society of America, Gilbert Ichthyological Society, The Wildlife Society

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: Member of technical panel for NMFS workshop on Assessing Extinction Risk for West Coast Salmonids. Seattle, 1996; Membership Committee, American Fisheries Society; Biological Review Team, Coastal Cutthroat Trout Status Review 1998; Biological Review Team, Klamath Mountains Province Steelhead 2001.

SELECTED PUBLICATIONS:

Spence, B. C., T. H. Williams, E. P. Bjorkstedt, and P. B. Adams. 2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA.

Currens, K. P., F. W. Allendorf, D. Bayles, D. L. Bottom, C. A. Frissell, D. Hankin, J. A. Lichatowich, P. C. Trotter, and T. H. Williams. 1998. Conservation of Pacific Salmon: response to Wainwright and Waples. *Conservation Biology* 12(5):1148-1149.

Williams, T. H., K. P. Currens, N. E. Ward III, and G. H. Reeves. 1997. Genetic population structure of coastal cutthroat trout. Pages 16-17 in J. D. Hall, P. A. Bisson, and R. G. Gresswell, editors. *Sea-run cutthroat trout: biology, management, and future conservation*. Oregon Chapter, American Fisheries Society, Corvallis, OR.

Allendorf, F. W., D. Bayles, D. L. Bottom, K. P. Currens, C. A. Frissell, D. Hankin, J. A. Lichatowich, W. Nehlsen, P. C. Trotter, and T. H. Williams. 1997. Prioritizing Pacific salmon stocks for conservation. *Conservation Biology* 11:140-152.

Williams, T. H., and R. G. White. 1990. Evaluation of pressure-sensitive radio transmitters used for monitoring depth selection by trout in lotic systems. *American Fisheries Society Symposium* 7:390-394.

Williams, T. H., and G. H. Reeves. (In Press). Ecological diversity and risk of extinction of Pacific salmon and trout. NOAA-NMFS Technical Memorandum XXXXX.

CURRICULUM VITAE

NAME: MARY M. YOKLAVICH

PRESENT POSITION: Research Fishery Biologist, Habitat Ecology Team

EDUCATION: M.S., Marine Sciences, Moss Landing Marine Labs, San Francisco State University, 1982; B.A., Biological Sciences, University of California, Santa Barbara, 1973.

PAST EXPERIENCE:

1988-present	Research Fishery Biologist National Marine Fisheries Service Alaska Fisheries Science Center, Seattle Pacific Fisheries Environmental Laboratory, Pacific Grove SWFSC, Santa Cruz and Tiburon, California
1989-1991	Research Associate Moss Landing Marine Labs and Elkhorn Slough Foundation Moss Landing, California
1984-1988	Senior Research Assistant, Oregon State University College of Oceanic and Atmospheric Sciences Newport, Oregon

RESEARCH INTERESTS: Species - habitat associations, developing new technologies to study deepwater habitats, marine protected areas, larval and juvenile fish ecology, environmental effects on coastal marine fishes.

HONORS AND AWARDS: Distinguished Fellow in Science and Technology, California State University, Monterey Bay, 2000; Bronze Medal - Superior Federal Service, U.S. DOC, 1998; Nominee for Pew Fellows Program in Marine Conservation, 1998; NOAA Monterey Bay National Marine Sanctuary Science Award, 1998; NOAA Performance Awards, 1988, 1992-98.

SELECTED SERVICE ON SCIENTIFIC COMMITTEES: California Marine Life Protection Act Master Plan Team, 2000-present; PFMC, Advisory Committee on Marine Reserves, 1999-2001; NOAA-NMFS Protected Resources panel member for "Candidate Species", 1997-present; NOAA-NMFS Essential Groundfish Habitat Core Team, 1996-1999; NOAA-NMFS Advisory Team For Gear Impacts, 1998;

SELECTED PUBLICATIONS:

Love, M.S., M. Yoklavich and L. Thorsteinson. (In Press) Rockfishes of the Northeast Pacific. University of California Press.

Johnson, K.A., M.M. Yoklavich, and G.M. Cailliet. (In Press) Recruitment of three species of juvenile rockfish (*Sebastes* spp.) on soft benthic habitats in Monterey Bay, California. CalCOFI Reports.

Yoklavich, M., G. Cailliet, D. Oxman, J.P. Barry, and D.C. Lindquist. (In Press) Fish assemblages of Elkhorn Slough and adjacent habitats. In Caffrey, J. (Ed.). Ecosystem Changes in a California Estuary: a Characterization of Elkhorn Slough.

Yoklavich, M., H. G. Greene, G. Cailliet, D. Sullivan, R. Lea, and M. Love. (2000). Habitat associations of deep-water rockfishes in a submarine canyon: an example of a natural refuge. Fishery Bulletin, U.S. 98:625-641.

Yoklavich, M. (Ed.) (1998). Marine harvest refugia for west coast rockfish: A workshop. NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-255. 159 p.(also now available online at www.pfeg.noaa.gov).

Yoklavich, M., V. Loeb, M. Nishimoto, and B. Daly. (1996). Nearshore assemblages of larval rockfishes and their physical environment off central California during an extended El Nino event, 1991-1993. Fishery Bulletin, U.S. 94:766-782.

APPENDIX B

PUBLICATIONS OF THE SANTA CRUZ LABORATORY

1999 - 2001

CURRENT MANUSCRIPTS

Alonzo, J. J.

In prep. Sexual Selection and Reproductive Success in *Symphodus mediterraneas*, a Mediterranean Wrasse.

Alonzo, J. J., and R. B. MacFarlane.

In prep. Smoltification in Chinook Salmon (*Oncorhynchus tshawytscha*) from California s Central Valley.

Boughton, D. A., and U. Malvadkar.

Submitted. Extinction risk in successional landscapes subject to catastrophic disturbances. Conservation Ecology.

Day, G. R., **C. B. Grimes** and D. A. DeVries.

In prep. Distribution, abundance, growth and mortality of striped anchovy, *Anchoa hepsetus*, along environmental gradients associated with the Mississippi River discharge plume.

DeVries, D. A., **C. B. Grimes** and **M. H. Prager.**

In prep. Using otolith shape analysis to distinguish eastern Gulf of Mexico and Atlantic Ocean stocks of king mackerel. Fish. Res.

Grimes, C. B. and D. A. DeVries.

In prep. Growth and mortality of Spanish mackerel larvae along environmental gradients associated with the Mississippi River discharge plume.

Grimes, C. B. and C. S. McNeil.

In prep. Diet and feeding ecology of striped anchovy, *Anchoa hepsetus*, along environmental gradients associated with the Mississippi River discharge plume.

Isely, J. J., **C. B. Grimes** and A. W. David.

In prep. Identification of hatchery-reared and wild red drum, *Sciaenops ocellatus*, using discriminant analysis of otolith banding patterns.

Johnson, R. C., C. B. Grimes, and **C. F. Royer.**

In prep. Discrimination of hatchery and wild chinook salmon (*Oncorhynchus tshawytscha*) in the California Central Valley using otolith microstructure.

Johnson, R. C., and R. B. MacFarlane.

In prep. Estuary use and growth history of juvenile Chinook salmon from the California Central Valley juvenile in the San Francisco Bay Estuary.

Laidig, T.E., D. E. Pearson and L. L. Sinclair.

In prep. Age and growth of blue rockfish (*Sebastes mystinus*) from central and northern California.

Laidig, T. E., K. M. Sakuma and J. A. Stannard.

In prep. Description and growth of larval and pelagic juvenile *Sebastes wilsoni*, pygmy rockfish (Family Scorpaenidae).

Lindley, S. T. and M. S. Mohr.

In review. Predicting the impact of striped bass (*Morone saxatilis*) stocking on the endangered Sacramento River winter chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences.

Loeb, V., **R. C. Johnson**, and E. Linen.

In prep. Distribution of krill, salp and other zooplankton taxa around Elephant Island during the 1998 Austral summer. Antarctic Journal.

MacCall, Alec D., and Thomas C. Wainwright (editors).

In prep. Assessing extinction risk for West Coast salmon: Proceedings of the workshop. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-??.

Ralston, S., J. R. Bence, M. B. Eldridge, and W. H. Lenarz.

In review. An approach to estimating the spawning biomass of rockfish using a larval production method with application to *Sebastes jordani*. Submitted to U. S. Fishery Bulletin.

Ralston, S., A. D. MacCall, and D. P. Pearson.

In review. The status of black rockfish (*Sebastes melanops*) off Oregon and California in 2001. In: Status of the Pacific Coast Groundfish Fishery Through 2001 and Recommended Acceptable Biological Catches for 2002, Pacific Fishery Management Council, Portland, OR.

Ralston, S., W. H. Lenarz, and D. P. Woodbury.

In prep. Long-term variability in year-class strength of northern California rockfishes (*Sebastes* spp.) in relation to the larval ocean environment and young-of-the-year growth. Fish. Oceanogr.

Rau, G. H., **S. Ralston**, J. R. Southon, and F. P. Chavez.

In review. Upwelling, diet, and the condition of juvenile rockfish: a study using ^{14}C , ^{13}C , and ^{15}N natural abundances. Submitted to Limn. and Oceanogr.

Reynolds, J. A., T. M. Powell, and **S. Ralston.**

In review. Significant habitat associations for widow rockfish (*Sebastes entomelas*).

Reynolds, J. A., **S. Ralston**, and T. M. Powell.

In review. Temporal stability of the association between widow rockfish (*Sebastes entomelas*) and bottom depth.

Sponangle, S., G. Boehlert, R. K. Cowan, **C. B. Grimes**, M. J. Kingsford, J. M. Leis, K. Lindeman, S. G. Morgan, J. L. Munro, J. Pineda and A. Shanks.

In prep. Predicting self recruitment in marine populations: biophysical correlates.

Thomson, C. J.

In review. The human ecosystem. In: Leet, W., et al. (eds.). California's Living Marine Resources: A Status Report California Department of Fish and Game.

Williams, E. H., and S. Ralston.

In review. Distribution and co-occurrence of rockfish (Family Scorpaenidae) in the waters off southern Oregon and California. U. S. Fish. Bull.

Yoklavich, M. M. and G. M. Cailliet.

In prep. Deepwater habitat and fish resources associated with a marine ecological reserve: implications for fisheries management. Final Report to Marine Ecological Research Reserve Program, UC Sea Grant College System.

LIST OF PUBLICATIONS BY YEAR

PUBLICATIONS - 2001

Allman, R. J. and **C. B. Grimes**.

In press. The temporal and spatial dynamics of spawning settlement and growth of grey snapper, *Lutjanus griseus*, determined using otolith microstructure. Fish. Bull.

Garza J. C., Williamson E.

2001. Detection of reduction in population size using data from microsatellite DNA. Molecular Ecology 10: 305-318

Greene, H. G., **M. Yoklavich**, R. Kvitek, and N. Maher.

2001. Mapping rockfish habitats of the Monterey Bay National Marine Sanctuary. In: Carless, J. (Ed.) Ecosystem Observations, Annual Rept. Monterey Bay National Marine Sanctuary.

Grimes, C. B.

2001. Fishery production and the Mississippi River discharge. Fisheries 26:17-26.

Grover, Allen M., **Michael S. Mohr**, and Melodie L. Palmer-Zwahlen.

In press. Hook-and-release mortality of chinook salmon from drift mooching with circle hooks: management implications for California s ocean sport fishery. National symposium on catch and release in marine recreational fisheries. American Fisheries Society, Special Publication Series.

Johnson, K. A., **M. M. Yoklavich**, and G. M. Cailliet.

In press. Recruitment of three species of juvenile rockfish (*Sebastes* spp.) on soft benthic habitats in Monterey Bay, California. CalCOFI Reports.

Klamath River Technical Advisory Team.

2001. Ocean stock size projections and prospective harvest levels for Klamath River fall chinook, 2001 season. Klamath Fishery Management Council, Yreka, California.

Laidig, Thomas E.

In press. Deep slope fishes. In Gulf of the Farallones Atlas, sponsored by the USGS.

Laidig, Thomas E., Kelly R. Silberberg, and Peter B. Adams.

In press. Validation of the first, second, and third annulus from the dorsal fin rays of lingcod (*Ophiodon elongatus*). NOAA Tech. Memo.

Levin, P. S. and **C. B. Grimes**.

In press. Conservation and management of grouper. In: P.F. Sale (ed.) Ecology of coral reef fish. Academic Press.

Love, M. S., **M. M. Yoklavich** and L. Thorsteinson.

In press. Rockfishes of the Northeast Pacific. University of California Press.

MacCall, Alec D.

In press. Fishery management and stock rebuilding prospects under conditions of low frequency environmental variability and species interactions. *Bull. Mar. Sci.*

MacCall, Alec D.

In press. [Book review] Quantitative fish dynamics. *J. Am. Stat. Assn.*

MacCall, Alec D.

In press. Use of known-biomass production models to determine productivity of west coast groundfish stocks. *N. Am. J. Fish. Mgmt.*

MacCall, A. D., and S. Ralston.

In press. Erratic performance of logarithmic transformation in estimation of stock-recruitment relationships. *N. Amer. J. Fish. Manag.*

MacCall, Alec D., and Stephen Ralston.

In press. Is logarithmic transformation *really* the best procedure for estimating stock-recruitment relationships? *N. Am. J. Fish. Mgmt.*

MacFarlane, R. Bruce, and Elizabeth C. Norton.

In press. Physiological ecology of juvenile chinook salmon (*Onchorhynchus tshawytscha*) at the southern end of their distribution, the San Francisco Estuary and Gulf of the Farallones, California. *Fish. Bull., U.S.*

Norton, E. C., R. B. MacFarlane, and M. S. Mohr.

2001. Lipid class dynamics during development in early life stages of shortbelly rockfish and their application to condition assessment. *Journal of Fish Biology* 58:1010-1024.

Prager, Michael H., and Michael S. Mohr.

2001. The harvest rate model for Klamath River fall chinook salmon, with management applications and comments on model development and documentation. *North American Journal of Fisheries Management* 21:533-547.

Salmon Technical Team.

2001. Preseason report I: Stock abundance analysis for 2001 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

Salmon Technical Team.

2001. Preseason report II: Analysis of proposed regulatory options for 2001 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

Salmon Technical Team.

2001. Preseason report III: Analysis of council adopted management measures for 2001 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

Salmon Technical Team.

2001. Review of 2000 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

Silberberg, Kelly R., Thomas E. Laidig, Peter B. Adams, and Douglas Albin.
In press. Analysis of maturity in lingcod (*Ophiodon elongatus*). Cal. Fish Game.

Spence, B. C., T. H. Williams, E. P. Bjorkstedt, and **P. B. Adams.**
2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA.

Tomberlin, D., and J. Buongiorno.
In press. Timber Plantations, Timber Supply, and Forest Conservation. In: Mati Palo, ed., World Forests, Markets, and Policies. Kluwer Academic Publishers.

Williams, T. H., and G. H. Reeves.
In press. Ecological diversity and risk of extinction of Pacific salmon and trout. NOAA-NMFS Technical Memorandum XXXXX.

Yoklavich, M., G. Cailliet, D. Oxman, J.P. Barry, and D.C. Lindquist.
In press. Fish assemblages of Elkhorn Slough and adjacent habitats. In: Caffrey, J. (Ed.). Ecosystem Changes in a California Estuary: a Characterization of Elkhorn Slough.

PUBLICATIONS - 2000

Allee, R. J., M. Dethier, D. Brown, L. Deegan, R. G. Ford, T. F. Hourigan, J. Maragos, C. Schoch, K. Sealey, R. Twilley, M. P. Weinstein, and **M. Yoklavich.**
2000. Marine and estuarine ecosystem and habitat classification. NOAA Technical Memorandum NMFS-F/SPO-43. 43 p.

Bjorkstedt, E. P.
2000. Stock-recruitment relationships for life cycles that exhibit concurrent density dependence. Canadian Journal of Fisheries and Aquatic Sciences 57:459-467.

Boughton, D. A.
2000. The dispersal system of a butterfly: a test of source-sink theory suggests the intermediate-scale hypothesis. American Naturalist 145: 131 - 144.

Brodeur, R. D., G. W. Boehlert, E. Casillas, **M. B. Eldridge,** J. H. Helle, W. T. Peterson, W. R. Heard, **S. Lindley** and M. H. Schiewe.
2000. A coordinated research plan for estuarine and ocean research on Pacific salmon. Fisheries 25: 7 16.

Chai, F., **S. T. Lindley,** J. R. Toggweiler, and R. T. Barber.
2000. Testing the importance of iron and grazing in the maintenance of the high nitrate condition in the equatorial Pacific Ocean: a physical-biological model study. In: The Changing Ocean Carbon Cycle: a midterm synthesis of the Joint Global Ocean Flux Study. R. B. Hanson, H. W.

Ducklow, and J. G. Field (eds). International Geosphere-Biosphere Programme Book Series 5. Cambridge University Press.

Garza, J. C., and E. Desmarais.

2000. Derivation of a simple microsatellite locus from a compound ancestor in the genus *Mus*. Mammalian Genome 11: 1117-1122.

Goldwasser, Lloyd, **Michael S. Mohr**, Allen M. Grover, Melodie L. Palmer-Zwahlen, Scott Barrow, and Curt Melcher.

2000. The supporting databases and analyses for the revision of the Klamath ocean harvest model: a progress report. Klamath Fishery Management Council, Yreka, California.

Klamath River Technical Advisory Team.

2000. Ocean stock size projections and prospective harvest levels for Klamath River fall chinook, 2000 season. Klamath Fishery Management Council, Yreka, California.

Koenig, C. C., F. C. Coleman, **C. B. Grimes**, G. R. Fitzhugh, C. J. Gledhill, K. M. Scanlon and M. Grace.

2000. Protection of fish spawning habitat for the conservation of warm-temperate reef-fish fisheries of shelf-edge reefs of Florida. Bull. Mar. Sci. 66:593-616.

Lindley, Steven T., Michael S. Mohr, and Michael H. Prager.

2000. Monitoring protocol for Sacramento River winter chinook salmon, *Oncorhynchus tshawytscha*: application of statistical power analysis to recovery of an endangered species. Fishery Bulletin 98:759-766.

MacCall, Alec D., Stephen Ralston, Don Pearson, and Erik Williams.

2000. Status of bocaccio of California in 1999 and outlook for the next millennium. Status of the Pacific Coast Groundfish Fishery Through 1999 and Recommended Acceptable Biological Catches for 2000, Stock Assessment and Fishery Evaluation, Appendix. Pacific Fishery Management Council, 2130 SW Fifth Ave., Suite 224, Portland, Oregon, 97201.

MacFarlane, R. B.

2000. Use of the San Francisco Estuary by juvenile chinook salmon, p. 41-45. In: J. Cech, Jr., S. McCormick, and D. MacKinlay [eds.] Fish migration and passage. International Congress on the Biology of Fish, American Fisheries Society, Bethesda, MD.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and **E. P. Bjorkstedt.**

2000. Viable salmonid populations and the recovery of evolutionarily significant units.

Pacific Fishery Management Council Special Assignment Work Team.

2000. Protocol for industry sponsored salmon test fishery proposals. Pacific Fishery Management Council, Portland, Oregon.

Parker, S., S. Berkeley, J. Golden, D. Gunderson, J. Heifetz, M. Hixon, R. Larsen, B. Leaman, M. Love, J. Musick, V. O'Connell, **S. Ralston**, H. Weeks, and **M. Yoklavich.**

2000. AFS Policy Statement: Management of Pacific Rockfish. AFS Fisheries 25(3):22-30.

Parrish, R., J. Seger, and M. Yoklavich.

2000. Marine reserves to supplement management of west coast groundfish resources: Phase I Technical Analysis. Prepared for The Pacific Fishery Management Council, Portland, OR. 47 p.

Pearson, Donald E.

2000. Data availability, landings, and length trends of California s rockfish. U.S. Dept. Comm., NOAA, NMFS, SWFSC Admin. Rpt. SC-00-01. 94pp.

Prager, Michael H., and Michael S. Mohr.

2000. The harvest rate model for Klamath River fall chinook salmon: model definition, solution, and implementation. U.S. Department of Commerce, National Marine Fisheries Service, Southwest Fisheries Science Center, Administrative Report T-2000-01, Tiburon, California.

Sakuma, K. M., F. B. Schwing, M. H. Pickett, D. Roberts, and S. Ralston.

2000. The physical oceanography off the central California coast during May-June, 1998: a summary of CTD data from pelagic juvenile rockfish surveys. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-297, 78 pp.

Sakuma, K. M., F. B. Schwing, M. H. Pickett, and S. Ralston.

2000. The physical oceanography off the central California coast during March-April and May-June, 1990: a summary of CTD data from pelagic juvenile rockfish surveys. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-299, 80 pp.

Salmon Technical Team.

2000. Preseason report I: Stock abundance analysis for 2000 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

Salmon Technical Team.

2000. Preseason report II: Analysis of proposed regulatory options for 2000 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

Salmon Technical Team.

2000. Preseason report III: Analysis of council adopted management measures for 2000 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

Salmon Technical Team.

2000. Review of 1999 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

Salmon Technical Team.

2000. STT recommendations for hooking mortality rates in 2000 recreational ocean chinook and coho fisheries. Pacific Fishery Management Council, Portland, Oregon.

Schwing, F. B., C. S. Moore, S. Ralston, and K. M. Sakuma.

2000. Record coastal upwelling in the California Current in 1999. Calif. Coop. Oceanic Fish. Invest. (CalCOFI) Rep. 41:148-160.

Thomson, C. J., et al.

2000. Overcapitalization in the West Coast Groundfish Fishery: Background, Issues and Solutions.

Prepared for the Pacific Fishery Management Council by the Scientific and Statistical Committee, Economics Subcommittee. 116 p.

Weber, D. S., B. S. Stewart, **J. C. Garza**, and N. Lehman.

2000. An empirical genetic assessment of the severity of the northern elephant seal population bottleneck. *Current Biology* 10: 1287-1290 (cover photo).

Williams, Erik H., Alec D. MacCall, Stephen V. Ralston and Donald E. Pearson.

2000. Status of the widow rockfish resource in Y2K. In: Status of the Pacific Coast Groundfish Fishery Through 2000 and Recommended Acceptable Biological Catches for 2001, Stock Assessment and Fishery Evaluation, Appendix. Pacific Fishery Management Council, 2130 SW Fifth Ave., Suite 224, Portland, Oregon, 97201.

Williams, Erik, Stephen Ralston, Alec D. MacCall, David Woodbury, and Donald E. Pearson.

2000. Stock assessment of the canary rockfish resource in the waters off southern Oregon and California in 1999. Status of the Pacific Coast Groundfish Fishery Through 1999 and Recommended Acceptable Biological Catches for 2000, Stock Assessment and Fishery Evaluation, Appendix. Pacific Fishery Management Council, 2130 SW Fifth Ave., Suite 224, Portland, Oregon, 97201.

Yoklavich, M., H. G. Greene, G. Cailliet, D. Sullivan, R. Lea, and M. Love.

2000. Habitat associations of deep-water rockfishes in a submarine canyon: an example of a natural refuge. *Fishery Bulletin*, U.S. 98:625-641.

PUBLICATIONS - 1999

Adams, P. B., M. J. Bowers, H. E. Fish, T. E. Laidig, and K. R. Silberberg.

1999. Historical and current presence-absence of coho salmon (*Oncorhynchus kisutch*) in the central California Evolutionarily Significant Unit. NOAA, NMFS, SWFSC, Santa Cruz, Admin. Rep. SC-99-02. 42 p.

Adams Peter B., Erik H. Williams, Kelly R. Silberberg and Thomas E. Laidig.

1999. Southern lingcod stock assessment in 1999. Status of the Pacific coast groundfish fishing throughout 1999 and recommended biological catches for 2000. Pacific Fishery Management Council, Portland, Oregon. Appendix, 79 p. Pacific Fishery Management Council, Portland OR.

Bender, M., J. Orchardo, M. Dickson, R. Barber and **S. Lindley.**

1999. In vitro O₂ fluxes compared with ¹⁴C production and other rate terms during the JGOFS Equatorial Pacific experiment. *Deep Sea Research* 46: 637-654.

Boughton, D. A.

1999. Empirical evidence for source-sink dynamics in a butterfly: Temporal barriers and alternative states. *Ecology* 80(8): 2727 - 2739.

Buongiorno, J., S. Zhu, and **D. Tomberlin.**

1999. Modeling the Global and Asia-Pacific Forest Sectors: Experiences and Prospects. In: A.

Yoshimoto and K. Yukutake, eds., Global Concerns for Forest Resource Utilization: Sustainable Use and Management. Kluwer Academic Publishers. pp 169-182.

Greene, H. G., **M. M. Yoklavich**, R. M. Starr, V. M. O Connell, W. W. Wakefield, D. E. Sullivan, J. E. McRea, Jr., and G. M. Cailliet

1999. A classification scheme for deep seafloor habitats. *Oceanologica Acta* 22(6):663-678.

Grimes, C. B. and S. C. Tumer.

1999. The complex life history of tilefish, *Lopholatilus chamaeleonticeps*, and vulnerability to exploitation. Proceedings of symposium on Management of Long-lived Species, *Trans. Amer. Fish. Soc.* 23:17-26.

Jensen, G. C. and **R. C. Johnson.**

1999. Reinstatement and further description of *Eualus subtilis* Carvacho & Olsen, and comparison with *E. lineatus* Wicksten & Butler (Crustacea: Decapoda: Hippolytidae). *Proceeding of the Biological Society of Washington* 112(1): 133-140.

Klamath River Technical Advisory Team.

1999. Brood year 1992 Shasta River fall chinook, supplemental report. Klamath Fishery Management Council, Yreka, California.

Klamath River Technical Advisory Team.

1999. Ocean stock size projections and prospective harvest levels for Klamath River fall chinook, 1999 season. Klamath Fishery Management Council, Yreka, California.

Koenig, C. C., F. C. Coleman, A. M. Eklund and **C. B. Grimes.**

1999. Management and conservation of temperate reef fishes in the grouper - snapper complex of the southeastern United States. Proceedings of symposium on Management of Long-lived Species, *Trans. Amer. Fish. Soc.* 23:233-242.

Laidig, Thomas E.

1999. Cordell Bank, A haven for rockfishes. *Hydrosphere* (Newsletter of the Farallones Marine sanctuary Association). 5:5-9.

Lindley, Steven T., and Michael S. Mohr.

1999. The effect of striped bass predation on recovery of the endangered Sacramento River winter chinook: a Bayesian population viability analysis. In: Oregon Department of Fish and Wildlife and National Marine Fisheries Service, Management implication of co-occurring native and introduced fishes. Proceedings of the Workshop, October 27-28, 1998, Portland, Oregon, 243 p. (Available from National Marine Fisheries Service, 525 N. E. Oregon St., Suite 510, Portland, OR.)

MacCall, Alec D.

1999. Use of decision tables to develop a precautionary approach to problems in behavior, life history and recruitment variability. In: Restrepo, Victor R. (Ed.), Proceedings of the Fifth National NMFS Stock Assessment Workshop. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-F/SPO-40, p. 53-64.

MacCall, Alec D., Stephen Ralston, Don Pearson and Erik Williams.

1999. Status of bocaccio of California in 1999 and outlook for the next millennium. In: Status of

the Pacific Coast Groundfish Fishery Through 1999 and Recommended Acceptable Biological Catches for 2000, Stock Assessment and Fishery Evaluation, Appendix. Pacific Fishery Management Council, 2130 SW Fifth Ave., Suite 224, Portland, Oregon, 97201.

MacFarlane, R. Bruce, and Elizabeth C. Norton.

1999. Nutritional dynamics during embryonic development in the viviparous genus *Sebastes* and their application to the assessment of reproductive success. *Fish. Bull.*, U.S. 97:273-281.

Murray, S., R. Ambrose, J. Bohnsack, L. Botsford, M. Carr, G. Davis, P. Dayton, D. Gotshall, D. Gunderson, M. Hixon, J. Lubchenco, M. Mangel, **A. MacCall**, D. McArdle, J. Ogden, J. Roughgarden, R. Starr, M. Tegner, and **M. Yoklavich**.

1999. No-take reserve networks: sustaining fishery populations and marine ecosystems. *AFS Fisheries* 24(11):11-25.

Norton, Elizabeth C., and R. Bruce MacFarlane.

1999. Lipid class composition of the viviparous yellowtail rockfish (*Sebastes flavidus*) over the reproductive cycle. *J. Fish Biol.* 54:1287-1299.

Prager, Michael H., and Michael S. Mohr.

1999. Population dynamics of Klamath River fall chinook salmon: stock-recruitment model and simulation of yield under management. Klamath Fishery Management Council, Yreka, California.

Prager, Michael, Paul Spencer, Thomas Williams, Sharon Kramer, Peter Adams, Thomas Hablett.

1999. Southwest Regional Approach to Data Collection on California Coastal Salmonids: Report of a Workshop Held August 12-13, 1998. NOAA, NMFS, SWFSC, Santa Cruz, Admin. Rep. SC-99-03. 46 p.

Ralston, S.

1999. Trends in standardized catch rate of some rockfishes (*Sebastes* spp.) from the California trawl logbook database. NOAA, NMFS, SWFSC, Tiburon, Admin. Rep. T-99-01, 40 p.

Ralston, S., D. Roberts, K. M. Sakuma, and D. P. Woodbury.

1999. From El Niño to La Niña in the Gulf of the Farallones. *Eos, Transactions*, Volume 80, Number 46, pp. F565-566.

Restrepo, V. R., G. G. Thompson, P. M. Mace, W. L. Gabriel, L. L. Low, **A. D. MacCall**, R. D. Methot, J. E. Powers, B. L. Taylor, P. R. Wade, and J. F. Witzig.

1999. Technical guidance on the use of precautionary approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-F/SPO-31.

Sakuma, K. M., S. Ralston, W. H. Lenarz, and M. Embury.

1999. Effects of the parasitic copepod *Cardiodyctes medusaeus* on the lanternfishes *Diaphus theta* and *Tarletonbeania crenularis* off central California. *Environ. Biol. Fishes* 55:423-430.

Sakuma, K. M., S. Ralston, and D. A. Roberts.

1999. Diel vertical distribution of post-flexion larval *Citharichthys* spp. and *Sebastes* spp. off central California. *Fisheries Oceanogr.* 8:68-76.

Sakuma, K. M., F. B. Schwing, D. Roberts, C. Moore, K. Baltz, and S. Ralston.

1999. The physical oceanography off the central California coast during May-June, 1997: a summary of CTD data from pelagic juvenile rockfish surveys. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-265, 77 pp.

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